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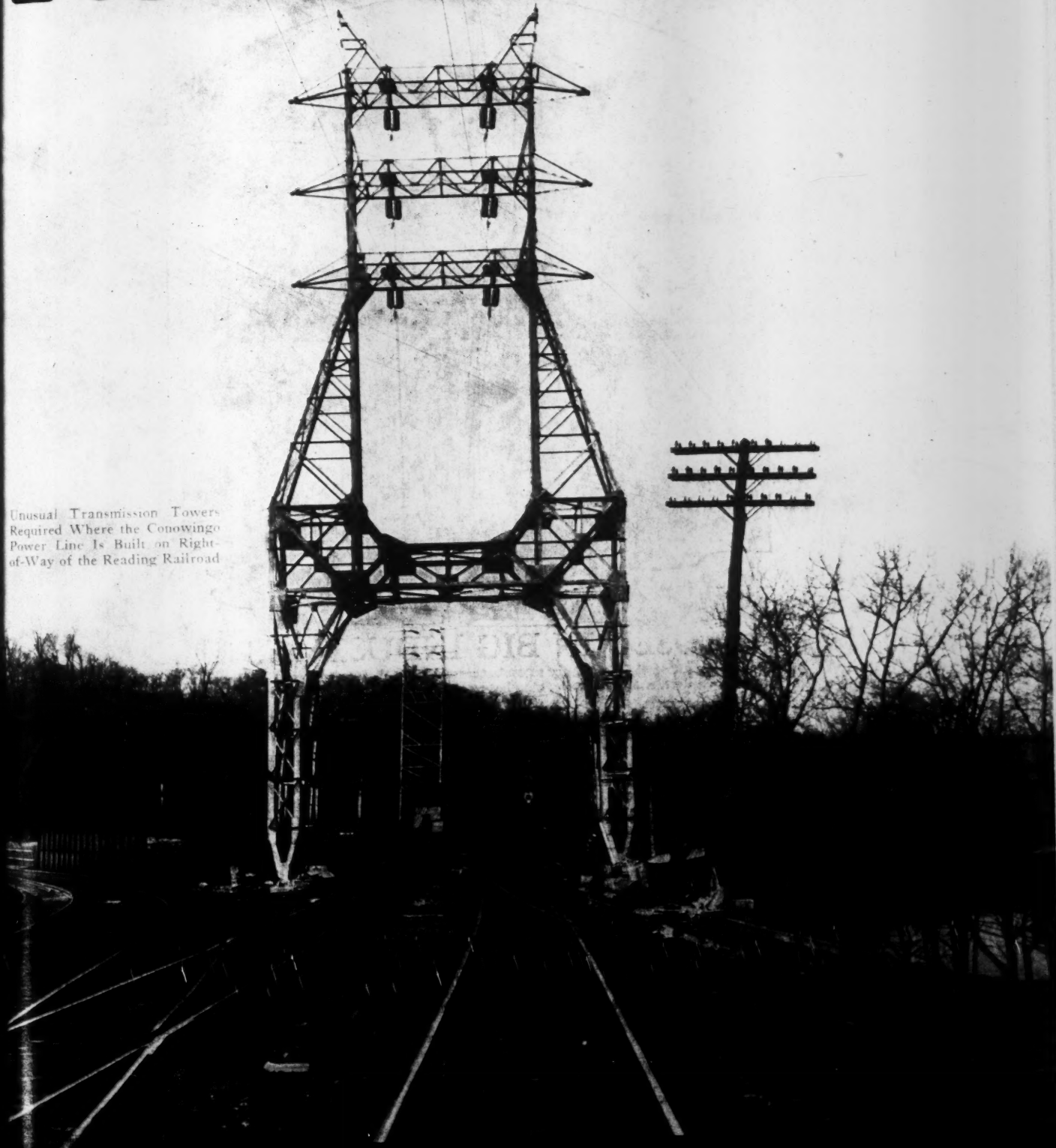

Unusual Transmission Towers Required Where the Conowingo Power Line Is Built on Right-of-Way of the Reading Railroad

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Cleveland Stands Fast

ONCE more the voters of Cleveland have declared for a continuance of their council-manager charter instead of going back to the mayor and ward-councilmen plan. As this is the second recent defeat of those who wish to abandon the manager plan, it may be assumed that it will be accepted for the present. By adopting the plan a few years ago and standing by it after a short trial Cleveland has given its answer to the claim that a manager may do for a small city but would be a failure in a large one. Cincinnati is contributing its practical experience to the same ends, and so are lesser but still respectable-sized cities. The city manager plan is proving a success in the larger as in the smaller cities. The test of performance as well as repeated popular approval warrants the expectation that it will raise the level of municipal administration.

Looking Backward

WORN trappings of long-departed days were brought out of a dusty storage closet a few days ago by George Otis Smith, director of the U. S. Geological Survey. "Chief of the liabilities of today," he said in an address, "is the excess of production capacity in most branches of industry," and he followed with this reason for the condition mentioned: "Too much efficiency is the explanation I would offer. The engineer has simply done his work too well." We are compelled to dissent. The doctrine that efficiency of production entrains economic evils has been discredited these many generations. Modern sense will not believe that the world is better off with slower, harder, more awkward production. The men of industry and business who strive constantly to improve their processes, eliminate wastes and better their yield are not on the wrong path. As the world moves steadily on, may we never come to a point where growth of man's powers is to be deplored—or where the engineer does his work "too well."

Justified Reserve

ONCE more the vexing question of whether diversion of the Great Lakes waters touches any inherent right comes to the front in discussions between the state authorities of Canada and the United States. In these discussions, it seems, Canada is taking the view that the legal question of the international status of the waters must be answered before individual remedies can be dealt with to any purpose. The attitude of our northern neighbor is one of reserve, but we think justified reserve. There are many complexities to this particular case of international waters, as may be seen from the ponderous volumes and great files of legal proceedings dealing with it. In a question between minor parties, perhaps, a single phase or detail of the question may alone be involved and may decide the issue without reference to underlying rights. But the status of the matter as between the two sovereign parties can hardly be fixed on a lasting basis unless the fundamentals are first disposed of. The Canadian action tends toward this end and should therefore prove to be constructive in the long run.

A Test of Service

SNOW becomes pronouncedly a more serious problem in highway administration as main roads are improved in grade and line and surfacing. Good investment sense demands that these costly properties shall be idle as little time as possible; but even more imperative is the demand of traffic that its business and its convenience shall not be disturbed. A reminder of these facts is at hand in the unseasonable snowfall last week in Pennsylvania, which called out the snow-fighting forces of the state highway department after its armament of plows and scrapers had been laid up for the summer or assigned to other duties. Incidentally let it be observed that the success with which the emergency was met came in no small degree from the fact that under the organization of the department snow removal is not the task of a special force recruited for snow fighting but is the duty of the regular maintenance forces which function the year around. When, therefore, the closing days of April covered the highways with a foot or more of wind-blown snow, the storm did not find a demobilized army, but one which was trained to spring to defense and vigorous counterattack even when taken by surprise. It is not the story of the battle that calls for attention, however, but the fact that traffic could not be permitted to suffer interruption even at the cost of battle. The few days' tie-up of traffic naturally resulting could not be permitted, although the energies of the department's 10,000 men were thereby turned to the one task of making the public thoroughfares free and open to every vehicle that desired to move. The occasion typifies the growing consciousness of service to traffic as the paramount purpose of the highway engineer's work. Who can doubt that the growth of this consciousness presages developments in safety measures, and in measures for dispatching the business of the highway user, which the road builder until recently has scarcely sensed as a duty?

Student Engineers

IN AN age in which so much depends on vision and proper planning as today, the attitude of the American Society of Civil Engineers toward its student chapters is encouraging. At Washington last week representatives from the collegiate chapters in the vicinity listened to instructive and inspiring talks on contemporary civil engineering projects, on society ideals and advantages and on professional responsibility. Later, a number of the stu-

dents were given opportunity to tell of their chapters' work. Such a conference has much to commend it. Not so many years ago a student chapter was little more than a local engineering organization, with only a mail-order connection with the national society. This was the condition in many of the chapters when the national society awoke to its responsibility to these neophyte engineers. But since then a series of contacts between members of the board of direction and of the student chapters, and the student conferences at the recent Asheville and Washington meetings of the society, have done much for the student members attending. The national society has been made more tangible to them. They are acquiring the necessary national outlook and a broader appreciation of the ideals of society work and professional responsibility. Perhaps these worth-while effects can be still further enhanced

City Waste Conservation

TO KEEP pace with the growth of the city the number of hogs engaged in utilizing the garbage of Los Angeles has been increased from 40,000 to 44,000 in the past few years. As elsewhere, the problem here has centered in finding a sanitary and economic method of getting rid of the large percentage of material that the hogs reject, augmented by the manure they produce. The obvious method is to convert it into fertilizer. That this is easier said than done, but can be done with good sanitary and economic results, appears from the article elsewhere in this issue. Both composting and heat drying having given rise to difficulties, the contractor resorted to air-and-sun drying on some four acres of concrete floors, followed by magnetic removal of cans, screening, pulverizing and a second screening. The end result is a powdered fertilizer, "always in demand among orange growers," as the article already mentioned states. Thus the garbage of one of our larger cities is turned into food for hogs and fertilizer for land. Nowhere else has garbage disposal been attacked with greater business and engineering skill or with greater apparent financial success. Part of the success is due to local conditions that favor hog feeding and to a close-at-hand fertilizer market. Climate is an aid particularly as regards the use of open-air drying floors. Elsewhere local conditions could doubtless be met provided equal engineering and business ability were used. Between the private hog ranch for garbage disposal and the city-operated plants for reclaiming salable and burning unsalable wastes, Los Angeles is setting an excellent example which other cities might well follow, with modifications to suit differing local conditions.

Whence the Colorado Silt

WHILE Congress continues to tarry in dealing with the problems of the Colorado River, the Department of Agriculture makes a significant contribution to knowledge of the problem through studies of the river's silt burden, carried out by S. Fortier and H. F. Blaney. It has been the accepted belief until now that all of the great volume of silt which the river carries down to its delta, there to become a menacing troublemaker, is brought in by the many tributary streams from the plateaus and deserts. No account has been taken of silt production in the main stream, particularly in the Grand Canyon. Hence the argument that a storage dam at the head of the Grand Canyon is equal to one at the foot in point of silt-detaining capacity. But now the investigators find, from careful comparison of silt contributions by the tributaries with the total silt volume carried down to the delta, that a considerable fraction of the latter comes from the Grand Canyon, since the silt from the tributaries does not account for all. This conclusion, they hold, is confirmed by consideration of the flow in the Grand Canyon, which they describe as a wonderfully efficient rock-grinding machine. They find also that the silt is a great and costly trouble to the irrigation farmer, and in addition—as has long been recognized—is the principal reason for the instability of the delta and the danger of destruction of the Imperial Valley lands, which lie below sea level. Their conclusions lay new emphasis on the importance of impounding the silt at the foot of the canyon section of the river, and thus strengthen the basis of fact on which rests the argument of those who hold that the Colorado River problem today demands a solution of comprehensive character.

Planning and Execution

A PROPOSAL has been made to President Coolidge by the board of direction of the American Society of Civil Engineers that the planning of the Mississippi River flood-control work be placed in the hands of a board of experts. This board is to be independent of the executive department of the government charged with both the planning and execution of the work under the bills now before Congress. The society's action is commendable for both its timeliness and its wisdom.

Dependence on expert counsel is in line with the best practice of large private corporations. No large private undertaking is begun until after the organization has obtained the advice of experts independent of its own engineering forces. The reasons for such a course apply with greater force in the case of the Mississippi River flood control, because of its vast size and its remarkable complexity.

Few will doubt the ability of the Corps of Engineers to execute a flood-control plan if directed by Congress to do so. But many doubt that the corps contains all the specialists required for a problem of this kind. The problem is one which requires specialists in rainfall and runoff, in river hydraulics, in the design of hydraulic structures, in the stability of earthen structures, and in the mechanical handling of earthen materials. Hence the value of authoritative consultants.

On such a board, some of the specialists would naturally come from the corps itself, but most of them will be found in civil life. The training of the officers of the corps purposely is so arranged as to give them a wide general experience in engineering. Few are permitted to become specialists as do many engineers in civil life. True, many members of the corps "know the river," but the present task is not one alone for men who know the river as it is; it is one for men who must anticipate what it will be like under quite different circumstances, when levees are raised to unprecedented heights, when revetments cut down the coefficient of friction, or when a spillway diverts many thousands of cubic feet per second from the main river to flood channels. To predict what will happen under such circumstances requires that the knowledge of men of quite different training be used to supplement the practical experience of the men who "know the river."

A Change in New Orleans

RESULTS of the April 17 election in Louisiana not only enable New Orleans to finance needed public improvements but also give the city some relief from control by the voters of the State of Louisiana. As noted in the editorial columns of *Engineering News-Record*, April 19, 1928, p. 613, New Orleans has been an extreme example of state control over cities, through the necessity of obtaining constitutional amendments to finance water, sewer and drainage extensions by bond issues.

It is all the more gratifying to record this victory for home rule since engineers headed the sponsoring committee of the local Association of Commerce to which much of the credit is given for the favorable vote of 13 to 1 in New Orleans and for the heavy majority throughout the rest of Louisiana. New Orleans engineers feel that the result is a justification of the plan adopted by them at the outset of the campaign. Briefly it consisted of keeping the issues free from maudlin sentiment, personal interests and partisan politics. Indorsement of all factions was obtained, but none adopted any of the proposals as a slogan. No small part of the "education" of the voter was due to the distribution of 500,000 pamphlets containing a questionnaire prepared by engineers. New Orleans can now proceed to pay its debt of honor for cutting the levee at Caernarvon last year, and extend its water, sewerage and drainage systems.

There is still a fly in the ointment for New Orleans, however. Although the city may issue bonds for water, sewer and drainage extensions without approval of the entire electorate of Louisiana, three separate local authorities and the local taxpaying electorate must indorse the bonds. There must be a three-fourths majority vote by the members of the sewerage and water board and a two-thirds vote by the city council, approval by a majority of property owners in both number and amount, and a three-fourths vote by the members of the board of liquidation of the city debt. This is a great advance over having to go to the entire Louisiana electorate, but still is unnecessarily cumbersome.

Yet perhaps the situation is not as bad as it seems. Obviously the city council must approve a bond issue for any purpose if it is to control the finances of the city. There may be local reasons why the board of liquidation should act, and it may be so constituted that its approval would be a foregone conclusion, once the other sanctions had been given. Referenda on bond issues are so common in the United States that this particular requirement at New Orleans would not be surprising except for two things: (1) Tieing in with an approval by three administrative boards; (2) the property qualification for voters in a popular referendum. This seems undemocratic in the extreme, but it is quite in keeping with vote restrictions, legal and extra-legal, in the South. It should be remembered, too, that Louisiana is a state quite by itself in origin and in forms of local government. Whether by coincidence or in part because of racial analogies, it is interesting to note that only a few months ago Montreal had a bond election of exactly the kind that is set up by the recent constitutional amendment applicable to New Orleans.

So far as New Orleans is concerned, the main point is that hereafter bond issues for water, sewerage and drainage purposes are under home rule. The four tie-ups mentioned, combined with a provision in the recent constitutional amendment that the total outstanding bond issues by New Orleans shall not exceed 5 per cent of the assessed valuation of all the property in the city, should be sufficient to keep the voters of Louisiana from lying awake nights lest the credit of New Orleans be impaired.

Short Lines Check Railway Mergers

FOR TEN YEARS this country has done nothing constructive on the subject of railway consolidation. Save for authorizing the absorption of a few lines into larger systems with which they were affiliated, we are just where we were when railway consolidation was adopted as a national policy. Whether this condition is due entirely to the inability of the Interstate Commerce Commission to formulate a basic plan for the railroads to work to or whether it is due to lack of adequate enabling legislation is not evident. Certain it is, however, that there are several knotty problems that are checking the efforts of the railroads to make some progress under the existing laws. One of them is the disposition of the so-called "short lines," the small, independent railroads, most of which are having a difficult time to make both ends meet.

A case in point is that of the New York Central's proposal to lease the Big Four and the Michigan Central, both of which lines it controls but does not own. When the New York Central applied to the Interstate Commerce Commission for permission to effect the lease, ten short lines in the region served by the New York Central Lines intervened, asking the commission not to approve of these leases on the ground that the Central's plan makes no provision for including the short lines.

It is inconceivable that the matter of whether certain short lines are or are not to be included in any grouping of several larger lines into one system could become a governing factor in deciding whether any one of the major lines should or should not be included. Yet if the commission is not to approve a consolidation plan unless the company presenting it is prepared to say what provision is going to be made for the short lines in its territory, then, obviously, it must gain control or at least come to an agreement as to the price at which it can gain control of the short lines before it can complete its plan. Such a condition puts a fictitious value on the short lines. On the other hand, if the major railroads are permitted to ignore the short lines entirely in making their consolidation plans, the changes in freight routing that will come about with the consolidation may deprive the short lines of so much freight as to bankrupt them.

Between the extremes of the one method of settlement which gives the short lines a fictitious value and the other which may result in their bankruptcy there must be a reasonable mean. It would appear to lie in an arrangement that would permit the major lines to proceed with their consolidation plans without having to consider the short lines beyond the point of agreeing to accept such of them as the Interstate Commerce Commission subsequently may assign to them at a price based upon the commission's published valuation of the short lines so taken. With such a law on the statute books, it is quite conceivable that it would seldom be invoked. The short lines, knowing that they cannot sell out at fictitious values, would, in most cases, prefer to come to some agreement as to purchase price with the trunk lines with which they connect rather than let the subject of their disposition be left to the Commerce Commission.

Unusual Towers on Conowingo Transmission Line

Section 4½ Miles Long Outside of Philadelphia Built Along and Over Railroad and Designed to Support Future Railway Electrification Catenaries

By Frederick W. Deck
Engineer of Design, Steel Tower Section,
Philadelphia Electric Company

ELECTRIC energy generated at the great Conowingo water-power project, recently completed by the Philadelphia Electric Company on the Susquehanna River, is transmitted at 220,000 volts to a large open-air substation about 10 miles outside of Philadelphia. It is taken from there into the city at 66,000 volts. About half of this last portion of the transmission line is built along the west bank of the Schuylkill River on the right-of-way of the Reading Railroad Company.

This section of the steel tower line, although only about 4½ miles long, embodies interesting and unique structural phases of transmission line work. It was built partly on the side of the right-of-way and partly over the tracks used by heavy traffic. Due to the limitations of the railroad right-of-way, already occupied to some extent by numerous shops, mills, yards and sundry structures, this job resolved itself immediately into a work largely of the adaptation of the structure to the ground, rather than of standardizing the structure. This in itself is a wide departure from the usual practice in transmission line engineering. Again, in accordance with the agreement between the electric company and the railroad, provision of supports for future electrification of railroad facilities within the limits of the transmission project had an important influence on design.

The line when complete is designed to carry four three-phase, 66-kv. circuits, arranged with phases vertical. The conductors are dead-ended to the crossarms at each structure through double strings of nine heavy-duty insulator units, with a standard dead-end clamp. The two ground wires also carried are dead-ended at each structure.

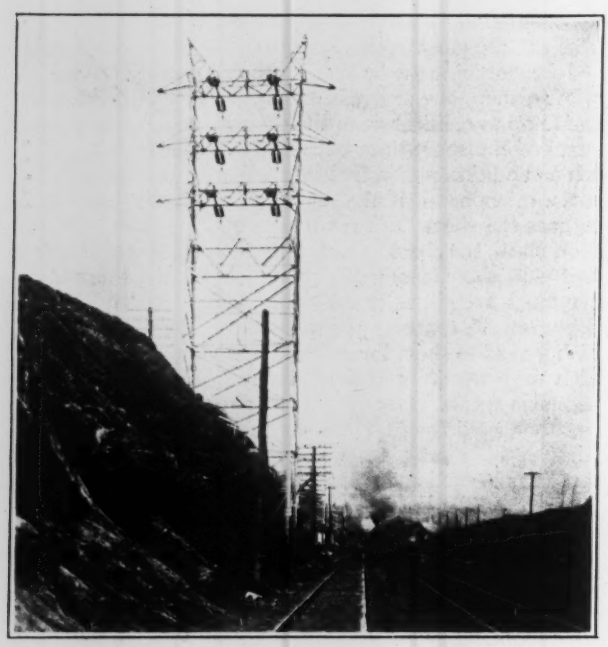


FIG. 1—FOUR-CIRCUIT TOWER ON CONOWINGO TRANSMISSION LINE

Future railway electrification will be supported on transverse catenaries spanning from tower to a support across the tracks.

Types of Structures—In all there are to be 46 supporting structures, 41 of which are being built at the present time. These are of seven general classes: (1) four-circuit tower, straight sides transversely, angles to 15 deg.; (2) four-circuit tower, straight sides transversely, angles 15 to 36 deg.; (3) two-circuit tower, narrow base, narrow waist, angles to 12 deg.; (4) two-circuit tower, sloping sides, on deflection angles to 60 deg.; (5) bridge structure, 66.5 ft. width, four-track span, angles to 5 deg.; (6) bridge structure, 40 ft. width, two-track span, angles to 5 deg.; (7) special Z-shaped structure, carrying four circuits, 90-deg. angle.

The first estimates of cost on the line were based on the use of large bridge structures spanning the tracks of the railroad. These were thought to furnish the only uniform method of support for twelve conductors, two ground wires and the railroad electrification system over the narrow right-of-way. It was early seen, after more detailed investigation, that the cost of this type of structure would become prohibitive due to limitations of space for the structure itself and its footings, its size and the need for mechanical and electrical clearances. A four-circuit tower to be placed on the rocky bank of one side of the right-of-way, varied by twin two-circuit towers and bridges where the former was not feasible, was then devised to surmount the difficulties involved in uniform bridge construction.

Suspension towers were at first contemplated, but it was deemed advisable to provide all structures with strain-insulator connections to reduce side swing, provide greater clearances, comply with crossing regulations in some instances and to eliminate uplift on suspension strings. This step had the effect of removing danger of overhang encroachment of adjacent properties and of allowing abrupt changes in height of structures as demanded by the high crossings over other utilities without the need of low gradients along the line of conductors. It was a step toward a much desired uniformity.

Where bridges are used, the catenaries for the future railroad electrification are suspended directly from the lower truss of the structure, the total weight being on the truss. Where towers on the side of the tracks are used, a transverse catenary attached to the tower on one side of the tracks and to a pole on the other supports the electrification system. In the case of twin two-circuit towers, the system is suspended from a transverse catenary supported by both towers. Ample clearance for the electrification system is obtained in the minimum vertical clearance of 45 ft. maintained between the lowest conductor and the rail.

In the case of all tower structures, a standard top section embracing the crossarms was adopted for the use of all towers of that particular type and designed

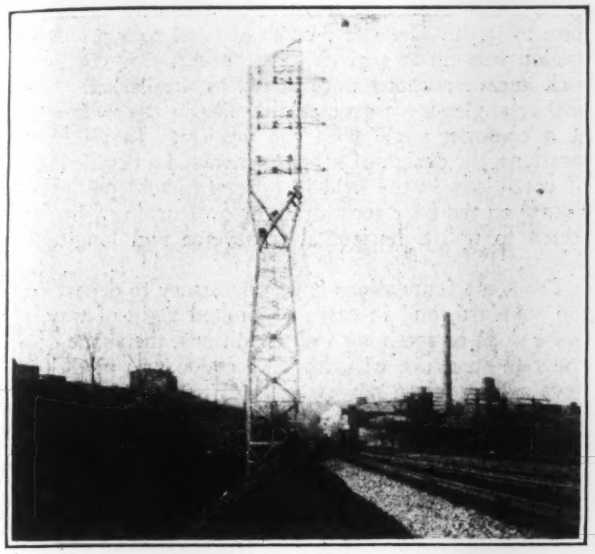


FIG. 2—TWO-CIRCUIT TOWER WITH NARROW WAIST AND NARROW BASE

Used where there was not room at side for four-circuit tower and where a six- or seven-track span bridge was impractical. The narrow waist principle was universally used in the design of the Conowingo towers outside of this railway area.

for the maximum angle applicable to that type. This applied also to the bridges. The next section of the towers, extending from the top section down to the point of attachment of the transverse cables of the railroad electrification system, was designed for the maximum angle of the type and consisted of a standard section of given height plus uniform sections 7½ ft. high to provide any required height of tower. The variation in tower heights occurred in this section. The special lower section, different in every case, extended to the standard steel shoe resting upon the footing. The top of this section was always at the same height above the adjacent rail. It was designed in each case for the catenary pulls applied and for the particular angle at that location. The attachment of a flexible suspension electrification system brought increased loads to bear upon the lower part of the tower.

The standard four-circuit tower has parallel sides transverse to the line and sloping sides parallel to the line. Two conductors are carried between the posts and one outside of each post, thus affording many advantages of accessibility, strength and clearance. There are two types of this general character, distinguished from each other primarily by the deflection angles in the line to which they are subjected.

The two-circuit tower used in twin arrangement has a narrow base and carries the conductors eccentrically, one circuit passing through the center line of the tower and the other on crossarms projecting toward the tracks. A greater lateral clearance in the narrow right-of-way is thus provided. These towers, built on the narrow waist principle used in the design of the main Conowingo line towers, afforded an excellent solution of the problem encountered in the layout of the line where there was not room at the sides of the tracks for four-circuit towers and where a six- or seven-track span bridge structure would have been impracticable.

For each of the three types of towers a standard shoe was designed, consisting of built-up steel plates and angle sections and fitting on top of a similarly made upper portion of the foundation steel, the whole being fastened together by large anchor bolts. This shoe received directly the posts of the towers.

The remaining type of tower, a two-circuit structure, is of the standard, sloping side, wide-base type used for large angles on lines through open country.

In the first class of bridge structure, spanning four tracks, there was barely enough space within the right-of-way limits and outside of the standard bridge clearance requirements of the railroad to place even narrow posts supporting the structure. In fact it became necessary to use in the lower part of the post an 18-in. I-beam section, longitudinally braced, which called for very heavy gusset plates to care for the enormous stresses at the top of these sections where the slope of the posts began. Again the limitations of right-of-way to some extent forced modifications in the shape and detailing of the structure which did not improve its appearance. On the transverse view these bridges were built with vertical posts to about 18 ft. above the rail, as above stated, and thence sloping in to the center to the width of the supports of the crossarm to a 21½-ft. width. A truss at an elevation about 32 ft. 8 in. above the rail joined the two posts, and served as a support for future electrification cables. The top of the structure embracing the crossarms is generally similar to the standard top for four-circuit towers.

The second type of bridge is similar to the first, but narrower, higher and of slightly different shape, being designed to span only two tracks and having framed posts instead of I-beam sections.

The supports of the bridge structures were pin-connected to the footings. This was effected by the use of a cast-steel shoe, which received the end of the post bearing upon a pin lying longitudinally in the shoe.

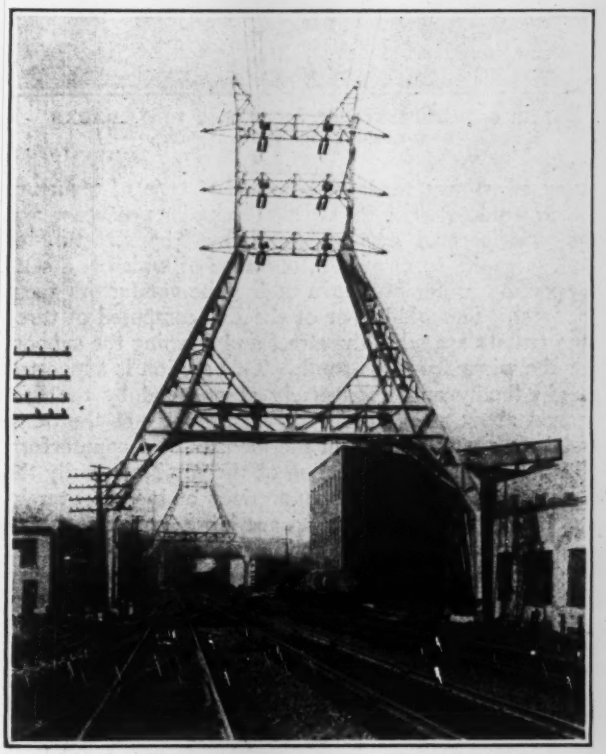


FIG. 3—BRIDGE TOWER SPANNING FOUR TRACKS

I-beam posts necessary to keep towers within right-of-way. Note heavy gussets. Railway electrification will be suspended from truss.

This avoided transfer of moment from the superstructure to the footings in a transverse direction, to the consequent benefit of the footings, universally limited in transverse strength. The cast-steel shoe rested directly upon the steel frame of the footing and was attached thereto by anchor bolts.

Probably the most unusual of all structures upon the job was devised for the purpose of carrying the conductors around a 90-deg. corner while simultaneously spanning railroad tracks and a street which already was elevated to cross tracks. Its shape was determined by the right-of-way available for points of support, and

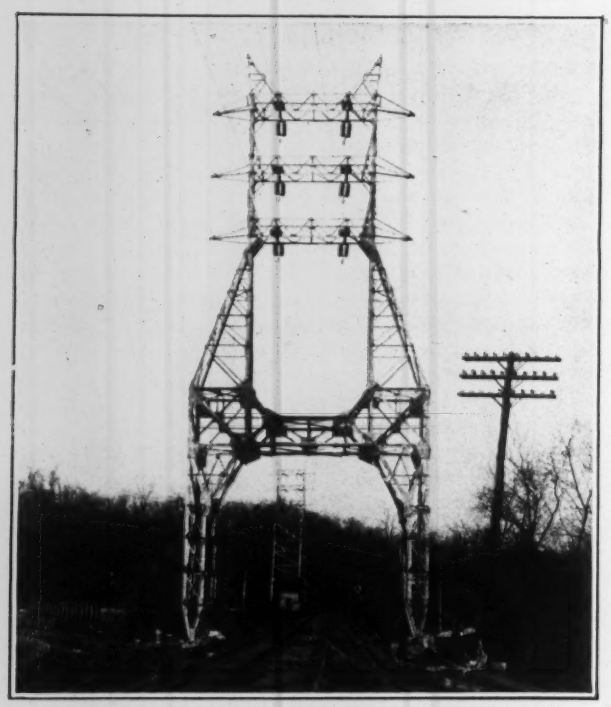


FIG. 4—BRIDGE TOWER SPANNING TWO TRACKS
Four-circuit tower in background.

every effort was made to obtain that type of structure which would at once satisfy the limitations of space and the principles of economic design. The structure as built is in the form of a Z, one face of which is a self-supporting bridge structure taking the conductors from the west. The middle bar of the Z is composed of three long trusses spanning the street and forming the support for the wires from the south. This section is supported longitudinally and transversely at one end by the first section above mentioned; and transversely at the other end by a narrow frame in the manner of a counterfort, which forms the third section of the Z. Necessarily the stresses due to dead-end connections at heights averaging 100 ft. above the ground are large, requiring heavy angle sections and sturdy footings. In this case the use of pin connections would have been of no benefit, even where possible, and the fixed connection formed by carrying the posts into the footing was found to afford added rigidity and strength to the structure as a whole.

The standard footing consists of a steel frame, the top section built up of angles to receive the steel shoe of the tower leg with its anchor bolts; the next section a narrow basket of steel posts and lacing to a point 9 or 10 ft. below the surface, where the posts are flared to provide the broad base necessary for bearing and resistance to uplift. In a few cases of hard rock, the basket section was cut at a given depth, and flaring corrugated rock anchor sections were bolted to the basket. These anchor angles were grouted in holes in the rock drilled at a common angle with the vertical. In all hillside locations, the design of footings involved a detailed study of conditions in the field in order to avoid pulling out, sliding on the poor rock strata or overturning when subjected to uplift, horizontal transverse and longitudinal forces.

For some foundations it was necessary to depart from the standard, and in cases of limited right-of-way, adverse slope or retaining wall conditions, the shape of the concrete structure with its steel frame was modified to have a long toe, a narrow base of extreme length or a greatly increased depth. The steel framework of the footing was invariably incased in concrete, conforming generally to the outline of the steel but "formed" only at the upper section. Due to provision made for changes in the track layout in the future, the footings on the upper side of the tower were often set deep in the bank to avoid moving them in the rearrangement. The consequent amount of excavation was great, and the concrete used was far in excess of that used in the standard footing to protect the steel buried in the earth.

In one instance it was necessary to build up the footing for a bridge structure where the post fell directly above a large sewer (Fig. 5). Since the lower ends of the posts on this side were already beyond the edge of a retaining wall, the sewer was bridged by heavy beams resting on one side on piers carried down to the level of the invert, and on the other on bearing plates in the retaining wall, which in turn were supported by concrete inserts about 8 ft. deep. Above the beams a steel extension was built up, and on top at the level of the tracks the standard steel shoe for bridges was placed.

The tower footings were subjected to heavy design loads, necessitating the weighty steel framework. In the four-circuit tower class the vertical loads imposed on the footings were as high as 472,000 lb., with horizontal reactions at the top of the footing up to 64,000 lb.

Design—All structures were designed to sustain the forces applied to them under the several conditions obtained by loading the conductors with ½ in. of radial ice, and 8 lb. of wind at 0 deg. F., or with 2 in. of radial ice and no wind. Transverse loadings included the usual elements of wind acting on all conductors loaded with ice, and on the structure, and the component of longitudinal pull due to angles in the line. Longitudinal and torsional loadings were due to several combinations of broken wires, or to the dead-end condition with all wires broken. The average span is about 600 ft.

All footings were designed to withstand the forces applied to them through the tower structures when the latter were loaded as stated above.

The insulators and hardware are of standard types of manufacture, of great strength, and are tested and investigated physically, electrically and mechanically to ascertain their satisfactory performance under severe conditions of loading (mechanical and electrical), of chemical action under exposure to gases from locomotives and steel mills and of physical deterioration in efficiency due to deposits of soot, etc.

The insulators are of porcelain, metal cap and pin, with a mechanical strength of 12,000 lb. The strength of the assembly of insulators and hardware is 24,000 lb.,

ultimate. The conductor is 500,000-circ.mil, bare-stranded hard-drawn copper, 0.814 in. diameter, and with an ultimate strength of 23,540 lb. The ground wire is $\frac{9}{16}$-in. Copperweld, extra-high-tensile, 0.546 in. diameter, and with a breaking load of 22,930 lb.

Surveys—The original survey of the line consisted of a series of cross-sections taken at intervals of 50 ft. or less at right angles to a random base line following generally the numerous curves of the railroad. These data afforded the regular topographical information required for the design of the line, including profiles, clearance studies and tower locations. When the final location of the structures had been decided upon, a detailed topographical study of each location was made, which furnished the data for determining the lower section of the towers. As a result of these data, two legs were in nearly all cases longer than the other two, and in only three instances were all of the legs of the same length.

From the established plans as then made, field locations were accomplished, and finally excavation and foundation data were given the field engineers from which they performed the very difficult task of setting precisely the heavy steel footings in rock or in uneven terrain. Two transits were used in placing and checking during and after pouring concrete in order to avoid costly errors which would make impossible the fitting of foundation steel and superstructure.

Construction—The construction of footings met with those usual difficulties found in work along a railroad under restricted conditions and in hillsides with both hard and rotten rock. Water, sometimes in very large quantities, was regularly present in most of the holes, requiring much time and labor to remove it either by siphoning or pumping. Drilling in rock was found to be a laborious and tedious process due to the irregular strata and rotten character of most of that encountered. Refacing of the hillsides was imperative in many cases at footing locations where the adjacent strata had sheared off. At some points holes were bored from the bottom of the footing excavation, normal to the slope line, to engage strata whose outcrop would be below the bed of the railroad. In order to prevent sliding, 1 in. square twisted rods were placed and grouted in these holes to a depth of 8 or 9 ft. and bent around the steel work of the footing at the other end. Scaffolding to two or three levels was constantly used on the construction of these footings, and concrete pouring was accomplished usually by a long chute from the top of the slope.

In most cases, except in some of the special footings, the steel frame was assembled in the hole, forms were

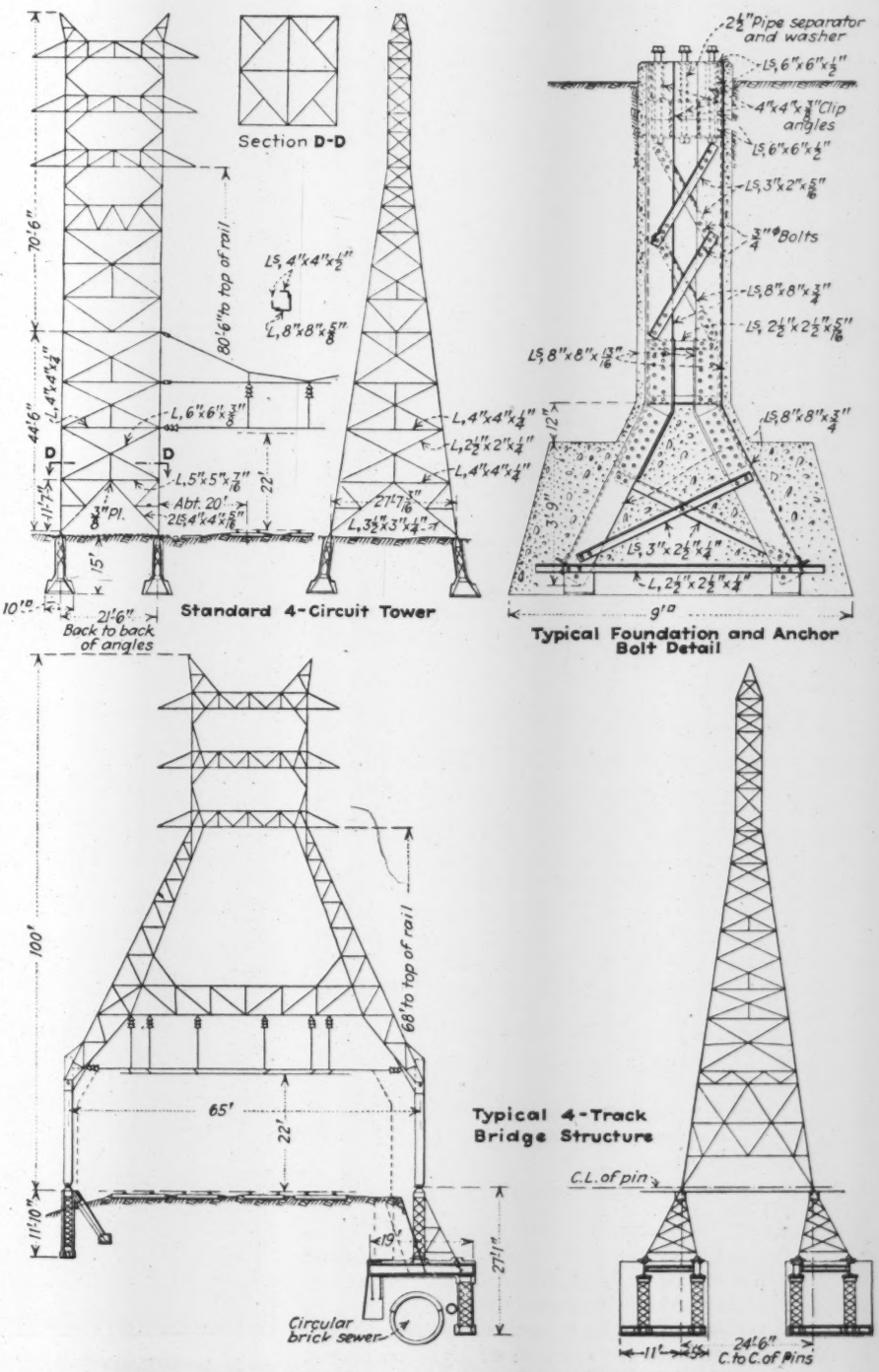


FIG. 5—TYPICAL DETAILS OF SPECIAL CONOWINGO TOWERS

built, and concrete was poured. Where possible on the upper section of the footing, standard forms were used. Mixing was done as required on the spot at the top of the slope or on a car equipped with bins, mixer and chutes in the work train.

In the erection of the towers the usual methods of tower construction prevailed, except that in some cases the setting of posts of the lower section was facilitated by the use of a large crane from the work train. In the upper sections a gin pole was used. The crane was useful in placing some of the steel footing frames in the holes, and in the case of the bridge structures it was indispensable in raising and holding in place the sections of the lower part, including the I-beam posts and the cross bridges weighing 20 tons or more. The I-beam posts were placed in position on the pins, longitudinal bracing was assembled and then, with these in place, the crane lifted the heretofore assembled lower truss (one face only) and held it in place while the connections were bolted. This operation had to be performed in record time because of the constant heavy railroad traffic. The remainder of the structure was erected using the part assembled as falsework. In other structures, including the special Z bridge, the crane was used where feasible to place and hold the sections while being bolted, but in general the members were assembled as in the case of the towers.

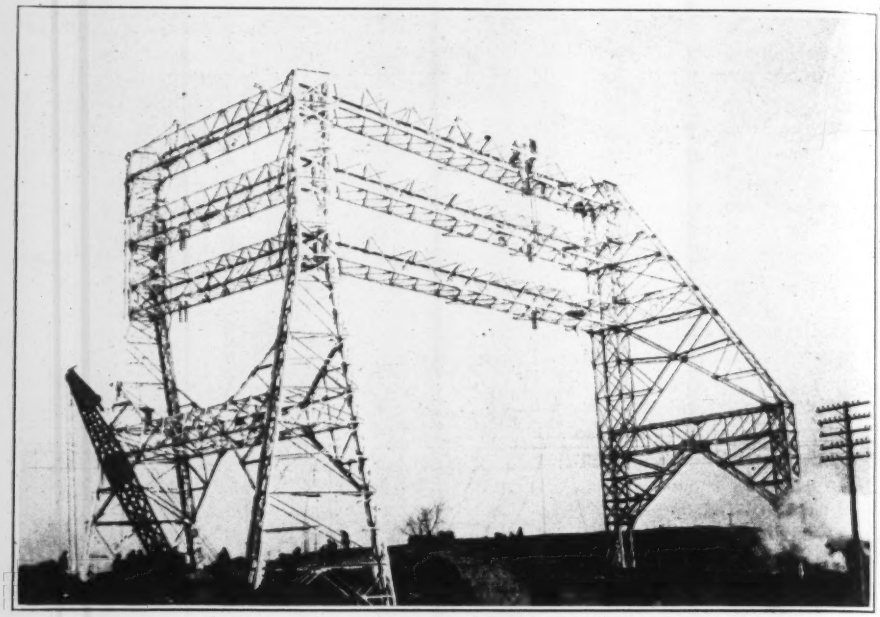


FIG. 6—SPECIAL Z-PLAN TOWER STRUCTURE
This tower carried conductors around a 90 deg. corner and over a street and the railway. The trusses, of 95-ft. span, are supported on the left by a self-supporting bridge frame and on the right by a narrow counterfort frame.

Conclusion—The writer has endeavored to give a description of this interesting bit of engineering work, which has seemed to him to be of a more concentrated variety than is usual in transmission line construction. The lack of right-of-way space was directly responsible for the unique character of the work. However, this avenue of approach through developed real estate of prohibitive costliness was the most feasible method of entering the city and was obtained through an agreement for mutual benefit entered into by the railroad and the electric company. It is believed that this joint use of right-of-way is but a forerunner of many similar future installations where like conditions are encountered. The successful operation under the agreement will assure other corporations of the possibilities of co-operation in the joint use of right-of-way not only to the advantage of themselves individually but of the public at large.

Advertising Signs Eliminated From New Brunswick Highways

Billboards, signs, posters or other means of advertising that might hinder the clear vision of the motorist or distract his attention from the road are prohibited along the highways of the Province of New Brunswick, by a new provision of the highway act. Previously the act had prohibited only the erection of signs on curves and approaches to curves.

Steel-Frame Construction for Residence Buildings

Trusses and Braced Vertical Members Formed by Shearing and Stretching Standard Angles and I-Beam Sections

A TYPE of steel-frame construction for residence buildings, which is now being introduced on a commercial basis, makes extensive use of members formed by shearing and stretching the edges of ordinary angles so as to form a diagonal brace. One of these units is shown in Fig. 1, and it will be seen that two units bolted or riveted together form a braced member. The application of these members is shown clearly in Figs. 2 and 4. The roof truss is similar in construction to the vertical wall members, but uses a tension strap welded on as a bottom chord. The floor beams are made from light steel I-beams which are slit in the web and then expanded to increase their depth, the entire member being one piece of steel.

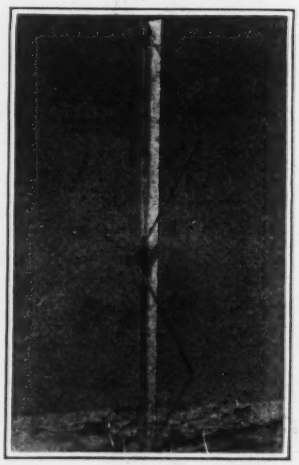


FIG. 1—SHEARED ANGLE FORMS BRACED MEMBER

Plumbing pipes and electric conduits are carried through the floor beams, being concealed by ceilings of plaster on expanded metal lath. Partitions and walls are formed in the same way, with a layer of insulating material in the exterior walls. Brick, stucco or block construction is employed for the curtain walls and architectural treatment, with wire binders to tie the wall to the steel framing.

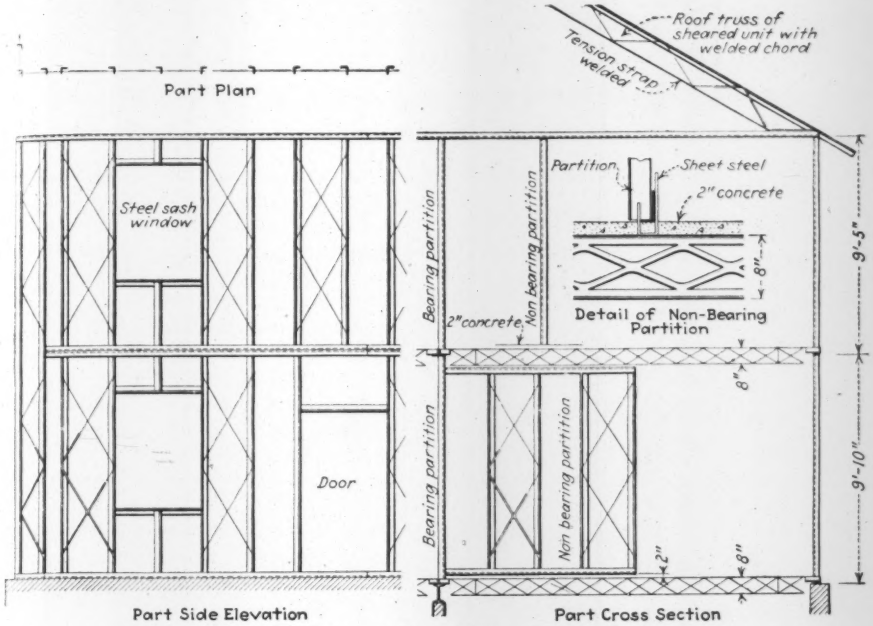


FIG. 2—STEEL-FRAME DESIGN FOR RESIDENCE

In these buildings steel framing is used throughout, even for stairways and partitions, as indicated by the interior view, Fig. 3. Some of the partitions carry no load, and these are put in place after the concrete floors have been poured, the members being connected to lugs which are attached to the floor beams and which extend above the concrete.

The first building of this type has been erected and others are under construction. Estimates of first cost of steel-frame and wooden-frame construction for the same building are said to show the former about 5 per cent higher for material but 8 per cent lower for labor, with a net saving of from 3 to 5 per cent in first cost for the steel-frame building.

In erection, a base angle is laid on the concrete foundations, punched to fit over anchor bolts and to receive the vertical members. These verticals are then placed, starting preferably at the corners, so that the first two members brace each other, and then working in both directions. As they are placed, the diagonal braces are bolted together, giving lateral rigidity. Structures built so far have been almost entirely bolted. The floor joists were welded to the wall framing and some other connections were also welded, but in general bolting was considered both better and cheaper. Experience may show the advantage of more welded connections.

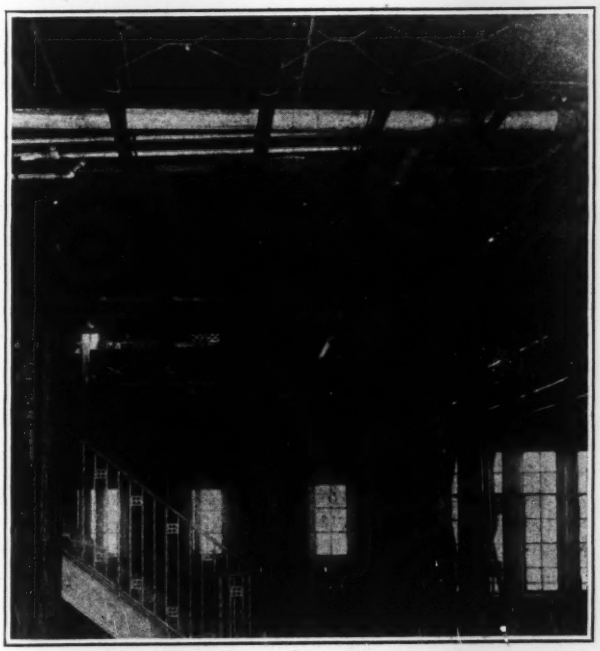


FIG. 3—INTERIOR OF STEEL-FRAME HOUSE
Note stairway. Piping carried through truss floor beams.

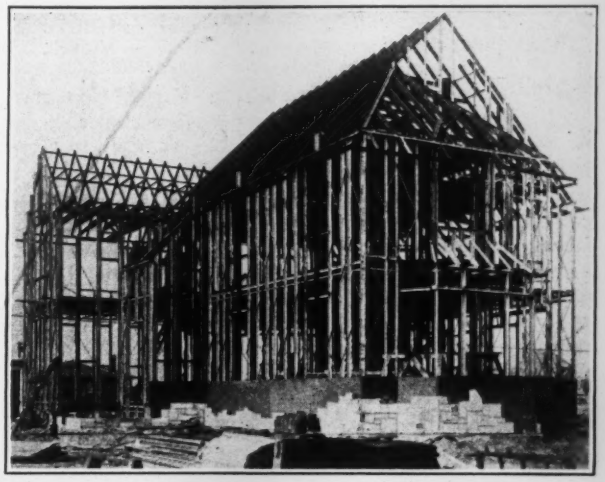


FIG. 4—ERECTING STEEL-FRAME RESIDENCE

This type of steel construction is being developed by the Walter Bates Steel Corporation, Gary, Ind.

Wisconsin Road Work for 1928

The 1928 construction program of the State Highway Department of Wisconsin includes about 260 miles of concrete paving and 1,400 miles of gravel and crushed rock surfacing. The commission states that it cannot give real highway service unless the dust nuisance is eliminated, especially on the heavily traveled roads, and it aims therefore to provide the highway traffic with several routes across the state that will be surface treated and free from dust. Experience in other states and the little experience gained in Wisconsin has led the commission to believe that the use of road oil for laying dust will result in a considerable saving in gravel, and that this saving, coupled with the decrease in patrol maintenance, will almost cover the cost of surface treatment.

Improving Waste Disposal at Garbage-Hog Farm

Drying Floors Replace Pit at Fontana Plant, New Equipment Successfully Producing Commercial Grade Fertilizer

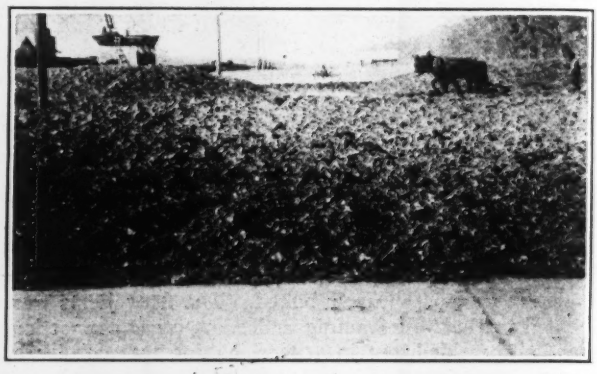
UTILIZATION OF HOGS for garbage disposal is as old and as universal as is the domestication of that animal. With the outlawing of hogs from urban areas, garbage has followed them to the country. The practice exists today, even as regards the table wastes of many sizable cities, but for the most part is not under centralized engineering control. A notable exception is afforded by the company that buys the garbage of Los Angeles, Calif., transports it 50 miles at the rate of 400 tons a day to a 40,000-hog ranch. Under conditions of large-scale operation and a ten-year contract it was practicable to organize and to build in a substantial way, and the company has met no troubles that could not be overcome either in protecting the hogs from epidemics or in maintaining the pens and feeding areas in a sanitary condition. Conversion of the immense volume of uneaten wastes and of hog manure into fertilizer has not been so easy. The way this problem has been met by the substitution of sun-and-air drying floors of concrete and a plant for separating foreign material and reducing the fertilizer to the proper condition for spreading on land is told in the following article. The use of other than man power for both the fertilizer operations and otherwise throughout the plant is notable. —EDITOR.

AT THE PLANT of Fontana Farms Company, about 50 miles east of Los Angeles, Calif., some 400 tons of Los Angeles table waste is received daily and fed to hogs, a total of about 44,000 animals being maintained. The plant was designed for economical operation over the ten-year period covered by the garbage contract, many acres of concrete feeding floors were laid and expenditure for structures and equipment was not spared wherever improved efficiency could thus be obtained. Six of the ten years covered by the contract have now passed. A general description of the Fontana plant and its operations was published in *Engineering News-Record*, Aug. 6, 1925, p. 208.

With a carefully laid out plant at the outset and with sufficient capital for necessary research, experiments of a practical sort have been carried on continuously to develop equipment and methods that would simplify the handling of garbage and make salable fertilizer from the waste scraped up in feeding floors and pens. After considerable pioneering, a fertilizer is being produced that is always in demand among orange growers because of its nitrogen and other organic content.

GENERAL VIEW OF NORTH HALF OF DRYING FLOOR
Old compost pit at left. Fertilizer in foreground is spread for drying; beyond first pole it is stacked in windrows.

The area of 160 acres comprising the plant as previously described has been increased to 240 acres, of which twenty acres is used for workmen's quarters and the remainder is inclosed by a high link-chain fence surmounted by barbed wire that effectively prevents trespassing and theft. In six years the quantity of garbage has increased 25 per cent, the daily average for 1927 being 9.4 cars of 42 tons each. The best quality garbage, rated as No. 1, has a moisture content of 68 per cent and generally speaking is a well-balanced food for hogs. Experiments have been made in increasing certain desirable elements by the addition of rice bran, tapioca meal, beans (which have to be cooked) and other foodstuffs that can be bought in large quantity at low price.



CLOSE VIEW OF REFUSE SPREAD OUT TO DRY
Note concrete floor in foreground. Two-horse teams do the plowing. Windrows of dry fertilizer in background.

The most notable change in the operation of the plant has been the substitution of concrete drying floors for the large compost pit that was expected to serve for the manufacture of fertilizer. The failure of this pit is ascribed to the fact that the material went in wet and packed itself down tightly enough to seal the contents. In this condition there was practically no drainage and the air was kept out. Instead of the disintegration that had been hoped for, the pit acted much as a silo, and individual pieces of garbage after being buried within the pit many months retained much of their original shape and condition. Such drainage as was taken off contained a high percentage of nitrogen, which is the most valuable element in the fertilizer.

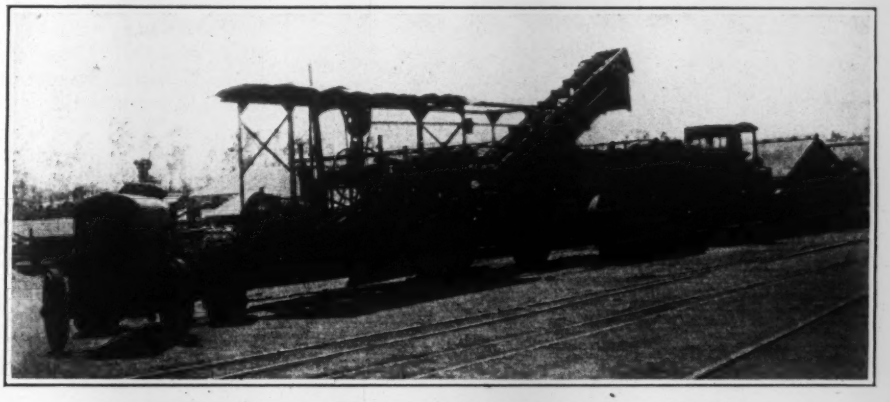
As a substitute for the compost pit a mechanical drier was tried, but this was hard to control and when overheating occurred it drove off valuable nitrogen. Sun-and-air drying was then adopted. Concrete drying floors 4 in. thick were laid on both north and south sides of the old compost pit, the areas paved being 100x550 ft. and 116x1,000 ft., respectively.

The material brought to these drying floors has a moisture content of about 65 per cent and varies from 120 to 125 tons per day. It is of two grades; No. 1,

scraped up twice daily from concrete feeding floors, consisting of garbage remnants and manure, and grade No. 2, pasture scrapings, consisting of refuse raked up every 30 days in the unpaved pastures and hence having a low nitrogen content due to loss into the earth. There is about six times as much of No. 1 as of No. 2.

The dump trucks hauling to the drying floors deposit their loads in piles which are immediately sprinkled with gypsum. The piles are spread to a depth of 8 to 12 in. by plowing with two-horse teams. Thereafter plowing is done once a day until the moisture has been reduced to about 15 per cent. The material can then be handled satisfactorily in the grinding plant, or it may be stacked by hand in windrows, usually made transverse to the length of the drying floor and piled about 10 ft. high.

In wet weather no plowing is done and the time is considered as lost. In the best drying weather the minimum time required to get down to the 15 per cent moisture content is five to six days. The maximum drying time, of course, depends upon the duration of wet weather, but even in winter storms are rarely prolonged and no difficulty on this score is expected, particularly as trucks may deliver as usual during wet weather, only the spreading being delayed.



MECHANICAL DEVICE FOR CLEANING FEEDING FLOORS
This rig, a scooping and elevating device, replaces 21 shovelmen that formerly loaded the trucks.

FERTILIZER ON CONCRETE DRYING FLOOR BEFORE SPREADING
The white powder is gypsum sprinkled over the piles when the dump trucks leave them. Windrow of dry fertilizer in background.

In addition to handling material removed from feeding floors and pens, the drying floors are used to condition material that has been in the compost pit as long as two years. A few days on the drying floors puts this material into such shape that it can be successfully handled by the grinding plant. Whereas the valuable nitrogen content leaches out of the material in the pit, on the drying floor it is dried and retained. The pit is now being emptied as fast as its contents can be handled and later may be roofed over and used for storing dried fertilizer.

The fertilizer-grinding plant has necessitated experiment at each step of its development and has given rise to complex problems because of the wide variety of material handled. The large quantity of rags and husks, for example, tends to clog some equipment, particularly the grinder for handling refractory material, and the pieces of bone, glass, etc., play havoc with blowers and pipes. However, by provision for each of the various classes of material the process as a whole has been made to succeed. There is no trouble with fats in the fertilizer, as they are consumed by the hogs.

From the windrows of dried material on the drying floors, dump trucks deliver into a hopper at the grinding plant. The hopper has a wedge-shaped bottom under which a conveyor belt, driven at slow speed (about 2 ft. per min.), feeds an inclined belt equipped with wooden cleats on 20-in. centers, moving at about 15 ft. per min. This belt delivers to the top of the plant, whence progress depends on gravity. The first segregation is made by a short belt 48 in. wide equipped with a magnetic pulley. This pulley holds the tin cans and other metal objects to the belt until after the other material has fallen off and therefore delivers all metals, totaling about 1 per cent of the gross weight, into a separate chute.

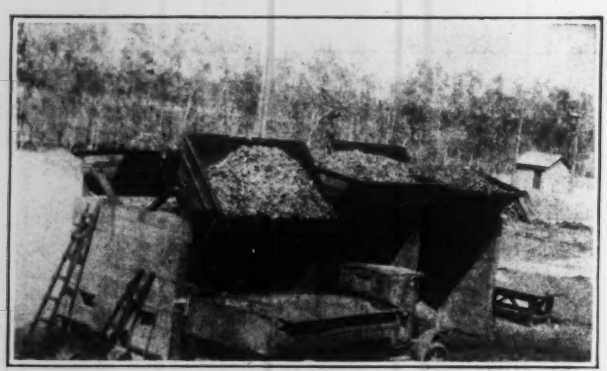
Large objects, including bones and the larger rags, are next removed by an inclined vibrating rack made of rods spaced 1½ in. apart. This rack catches 4 to 5 per cent of the gross weight of material delivered to the plant. The reject from this rack passes to a horizontal belt conveyor, from which two men pick off bones and rags. These items, amounting to 3½ per cent and 1 per cent, respectively, of the gross weight, are tossed into separate chutes, while material remaining on the belt, amounting to 25 per cent of the gross, passes directly to the grinder below.

The material passing through the vibrating rack goes to an inclined vibrating screen with ⅜x½-in. mesh. All that passes through this screen goes in with the ground product, whereas the reject passes on to the grinder.

The grinding is the most difficult process in the production of this fertilizer and has caused much experiment and delay. A small pulverizing mill of the hinged hammer type, operating at 3,000 r.p.m., ground up the material satisfactorily in the early stages of the development, but a larger size of the same make operated at 1,450 r.p.m., which was installed later, would choke up

with "fluff" (chiefly husks, rag fragments, etc.), and although this grinder had a rated capacity of 10 to 15 tons per hour, it could deliver no more than 4 tons of ground product per hour. That grinder was replaced by one working at 1,400 r.p.m. and having a rated capacity of 10 tons per hour. Although only recently put in, this grinder is believed to be able to do the work and has satisfactorily ground 8 tons per hour.

From the grinder, material is drawn by vacuum through a 40-hp. blower and delivered to a second



STEEL DUMP BOXES MOUNTED ABOVE TRUCK HEIGHT
These storage bins are filled from gondola cars by the locomotive crane. They dump by gravity to truck bodies. Drying floor at right.

vibrating screen, a duplicate of the one already mentioned except that the mesh is $\frac{5}{8}$x$\frac{3}{4}$ in. Material passing through this screen goes in with the ground product, whereas the reject is classified by an inclined bar rack, the function of which is to separate the rags and bone from the other rejected material that goes back to the grinder.

Screenings and ground product finally come together in a bin at ground level, whence a vertical bucket conveyor delivers to a horizontal screw conveyor the trough of which passes outdoors over the stock pile. This trough has numerous sliding doors in the bottom so that the product can be discharged at any desired point under the trough or into a bin under which trucks may load by gravity.

All equipment in the fertilizer plant is motor operated, for the most part individual motors being used on each machine or pulley, the sizes ranging from the $\frac{1}{2}$-hp. on the vibrating screens to the 125-hp. motor driving the grinder.

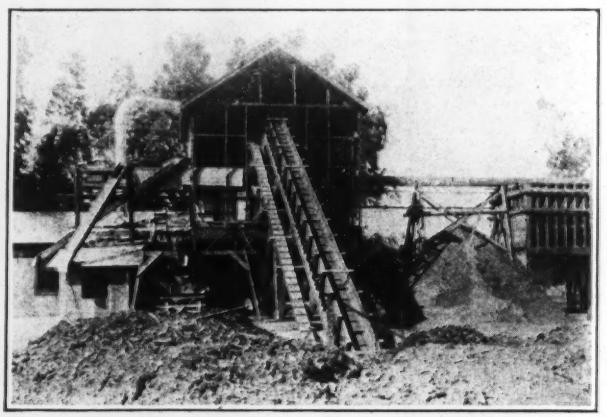
The ground fertilizer, all of which will pass a screen of $\frac{3}{8}$-in. mesh, has a nitrogen content of 2 to 2$\frac{1}{4}$ per cent and contains 50 per cent of organic matter. Material taken from the windrows on the drying floors, and therefore material that has not passed through the classifying and grinding plant just described, averages about 1$\frac{3}{4}$ per cent nitrogen and 48 per cent organic matter. These products, in both of which the moisture content is about 15 per cent, are sold at prices ranging from $5 to $8 per ton.

Apart from the successful development of equipment for producing fertilizer, other improvements in the operation of the garbage-feeding plant worthy of note are described in the following.

A considerable tonnage of garbage is delivered every day to pens, where the feeding has to be done by hand from wagons or trucks. Until recently these vehicles had to be filled by the locomotive-crane grab bucket that also does the feeding on floors along railroad tracks. It was not always possible so to schedule operations that the trucks for hand feeding could be loaded conveniently by this crane; therefore six 5-ton steel dump boxes were mounted above truck level on concrete piers alongside the main siding, where they can be filled conveniently by the locomotive crane whenever it comes to the siding for a fresh car. These boxes can be tilted by a hand winch, thus being made to dump into trucks that drive beneath them. The boxes are prevented from tipping over too far by a coil spring and cable fastened to one side; they are returned to an upright position after dumping by reversal of the hand winch.

Experience with the concrete feeding floors indicates that even with special care in getting the maximum density and tightness in the concrete finish some chemical action takes place there that ravels off the surface and requires a new cement coating in two to three years. (A 6-in. oiled macadam feeding floor was tried, but this was a complete failure.) The garbage remains in gondola cars from 24 to 42 hours, and although these cars are drained so that liquid cannot collect in the car, the garbage is nevertheless quite wet (65 to 68 per cent moisture) when deposited on the floor. Raveling of the concrete occurs much more rapidly in those areas where the garbage is deposited than it does around the sides of the floors or anywhere else in the paved areas. (No raveling whatever has been observed thus far on drying floors that have been in use two years.)

The concrete feeding floors are 4 in. thick, the lower 2$\frac{1}{2}$ in. of which is a 1:2:4 mix and the upper 1$\frac{1}{2}$ in. of which is a 1:3 mortar. The surface is covered and kept



FERTILIZER GRINDING PLANT, FRONT VIEW
Product of drying floors, in foreground, enters plant on belt conveyor. Ground product delivered to pile in background.

wet for 30 days after pouring and then a floor hardener is used to close the pores. The hardener is made by adding 3 lb. of magnesium fluosilicate to a gallon of water, this mixture being applied in three coats of varying strength. The first coat consists of one part by volume of the mixture with two parts of water. For the second coat the mixture is diluted with an equal quantity of water and for the third coat two parts of the mixture are used with one part of water.

The mixture costs about 16c. per pound or 48c. per gallon and the cost for three coats amounts to about 1c. per square foot. One pound of the magnesium fluosilicate is needed for each 38$\frac{1}{3}$ sq.ft. of surface treated. The second and third coats are applied 24 and 36 hours respectively after the previous coats have been put on.

The operating crew at the plant, which now consists of about 112 men, has been materially reduced by the development of a mechanical loading device for gathering up waste from the concrete feeding floors. Under the old plan of cleaning these floors two fresno outfits were followed by 21 shovelmen serving six trucks that hauled away the material cleaned up. Now two men with horse-drawn V-scrapers go first along the feeding floors to move the leavings away from the side walls and into a central windrow. The loader with a crew of two men follows and in one operation cleans up the windrow, loading it into trucks that move along under the delivery end of the conveyor belt on the loader. Six 1-ton dump trucks with steel box bodies and two 5-ton dump trucks constitute the complete truck fleet.

The 55 gondola cars that were specially equipped six years ago for carrying garbage from the city to the plant are still in excellent condition. They are inspected once each trip for leaks, loose rivets or other defects and about 10 per cent of this number are ordinarily in the railroad company's repair shop being conditioned. Every car is cleaned with steam jets after being unloaded at the plant to keep it in a highly sanitary condition.

The hog farm is one of the departments of the Fontana Farms Company, operating under the general direction of A. B. Miller, president. R. E. Boyle is the ranch superintendent. Acknowledgment is made to these officials for information used in this article.

Shall More Land Be Reclaimed?

Farmed Area Now Shrinking—Greater Yield Due to Mechanization—No More Land Is Now Needed

By F. H. Newell

Consulting Engineer, Washington, D. C.; formerly Chief Engineer and Director, U. S. Reclamation Service

MANY times in recent years it has been asserted that with the rapid increase in population of the United States it is necessary to make plans and begin the reclamation of waste lands in order to provide food for these additional millions of consumers. This fallacy is the foundation of arguments for increased activity and incidentally of large federal appropriations for reclamation —for irrigation, drainage, clearing of waste land and otherwise spending large sums in getting ready for an increased production of food. As a matter of fact, the studies of the Department of Agriculture show, despite the inevitable increase in the number of mouths to be fed, it does not follow that more land must be cultivated.

Cropped Area Decreasing—The census returns reveal a decrease between 1919 and 1924 of 13,000,000 acres of crop land. During that period the population increased by about 8,000,000, or fully 7 per cent. Despite the decreased area, the total agricultural production increased about 13 per cent, or twice as rapidly as population. During the same years the decrease in farm population was about 6 per cent. Fewer farmers are producing from a smaller acreage of land more food and fibers than the increasing population is able to consume at profitable prices to all farmers.

There is nothing strange about this development. It is strictly in line with modern progress; it is, in fact, the object for which hundreds of millions of dollars of taxpayers' money has been spent during the past few decades by the departments of agriculture, federal and state, by the agricultural colleges and by the experiment stations. Everything possible has been done to find new facts, to teach the farmer how to raise larger and better crops per acre and per man. Machinery has come into the fields, as it has into the factory. Tractors and auto trucks have displaced millions of draft animals and rendered unnecessary the cultivation of millions of acres of feed for these animals; the use of this land has been transferred to that of producing forage for meat and milk animals. Machinery operated by two or three men often is doing the work it would require 20 or 30 men or more to do by hand.

Effect of Farm Mechanization—The public now wakes up with surprise to find that the dream of mechanical efficiency on the farm is coming true. It did not realize, however, that when this did come true there must come some hardship and suffering to groups of farmers, comparable to that which always followed the introduction of machinery into any occupation. The very fact that the machine succeeds in doing the work of many men results, for a time at least, in depriving these groups of people of their customary means of livelihood.

In olden times the hand spinners and workers in other occupations arose in riotous mobs to destroy the new machines that were depriving them of the opportunity to get their daily bread. These conditions must always follow improvements in skill and knowledge unless at the same time the workers who are displaced are provided with other means of livelihood.

Our skill in business or economics of government drops far behind our inventiveness and ability in mechanical lines. The inventor and engineer is a generation or more ahead of the lawyer or lawmaker. He is constantly producing miracles that are upsetting the whole scheme of society. There is nothing new in this. Past generations have been unable to foresee the revolutionary effects of the work of the inventor and engineer.

There is no question as to the fact that improvements in methods and machinery are bound to increase even more rapidly than in the past. The good farmer, with good climate and good land and with intelligently directed co-operative marketing systems, can and will produce each year more food with less and less manual labor and probably on a stationary or at most very slowly increasing acreage. Quantity production means larger earnings per individual and less cost per unit of the food produced.

All this spells ruin for the poor farmer on poor soil and with poor marketing facilities. Thousands more must face the alternative of seeking other employment or else of dropping to a lower standard of living, adding their cries of despair to the demands for help to restore a condition that it is as impossible to rectify as it would be for the hand weavers to demand that the output of the great mills be limited. But so long as urban prosperity continues to afford employment to almost everyone, the losses in capital sustained by those farmers who are forced into the cities may be balanced, at least in part, by an income greater than they have experienced in agriculture.

With these conditions clear, it is difficult to perceive the wisdom of further public land-reclamation enterprises. Each of the individual movements for a new reclamation project is no doubt supported by strong motives of local benefit, but these can never justify expenditures made from national funds in the national interest. On the present outlook, then, more federal reclamation must be declared an unsound policy.

Studies on Prevention of Scour Below Overfall Dams

Review of Earlier Designs Made in Design for Mineral Ridge Dam—Former Studies Tabulated

By G. Gale Dixon
Deputy Chief Engineer, Mahoning Valley Sanitary District, Youngstown, Ohio

IN CONNECTION with the design of the proposed Mineral Ridge dam of the Mahoning Valley Sanitary District in Ohio, the writer has had occasion to examine the literature which has been built up during recent years in scattered articles on both the experiments with and the actual applications of various methods for preventing dangerous erosion below the toe of overfall dams. These means have taken nearly every conceivable form except the homologue of the positively controlled hydraulic jump as developed in connection with the design of the outlet conduits for the dams of the Miami Conservancy District by the able technical staff of that organization.

The writer ventures to offer a bibliography covering some of these types as classified in accordance with his rather casual terminology and briefly to present the results of the detailed studies made for the Mineral Ridge dam which led to the preparation of detailed plans based on the utilization of the controlled hydraulic jump in conformity with conclusions identical with those so concisely and lucidly set forth in Prof. Sherman M. Woodward's letter in *Engineering News-Record* of Dec. 15, 1927, p. 974.

Regarding classification, it should be said that an adequate terminology would divide the cases in which the level of tailwater is naturally high enough to prevent the unaided occurrence of a hydraulic jump on the apron or in the channel from those in which it is not.

COMPARISON OF THE SEVERAL TYPES OF SPILLWAYS

Type	Excess Cost as Compared With Type I	Advantages	Disadvantages
I. Conventional ogee	.....	Lowest cost of construction.	The hydraulic jump will be choked off by high tailwater stage, but uncontrolled high bottom velocities may erode bottom of tail-bay beyond end of apron.
II. Toe pool	$17,160	Positive partial absorption of excess energy of falling sheet by impact and turmoil in toe pool.	Weakens structure at toe by form of construction. Utilizes impact upon the structure for absorption of energy.
III. Impact weir	$12,600	Checks velocity of falling sheet by angular deflection at toe, and bottom velocity on apron by impact on a low weir farther downstream.	Same as Type II, but in lesser degree for both items. Uncertainty as to identity of performance between small-scale model and the actual structure, as the action is controlled by no known specific law.
IV. Baffle piers	$20,895	Performance has been established by experiments upon a closely homologous model for Pit River dam No. 3.	Highest cost of construction. Utilizes impact upon the structure in part for absorption of energy. Piers are subject to damage or clogging by drift and ice in spillway discharge.
V. Inclined apron	$10,745	Forces hydraulic jump to occur on thick apron near toe, absorbing energy by internal turmoil of water instead of shock on structure. Water will pass over weir smoothly with no danger of erosion below it. Operates under well-established definite laws which permit considerable accuracy in predicting performance. Form of construction at toe strengthens the structure.	

Bibliography of Hydraulic Jump Papers

1. *Spillway With Stepped Face:*

Examples: Croton, Ashokan and Gilboa dams of the New York water-supply system.

Experiments: "Experiments With Models of the Gilboa Dam and Spillway," R. W. Gausmann and C. W. Madden, Vol. 86, *Transactions*, Am.Soc.C.E., p. 280. (1923).

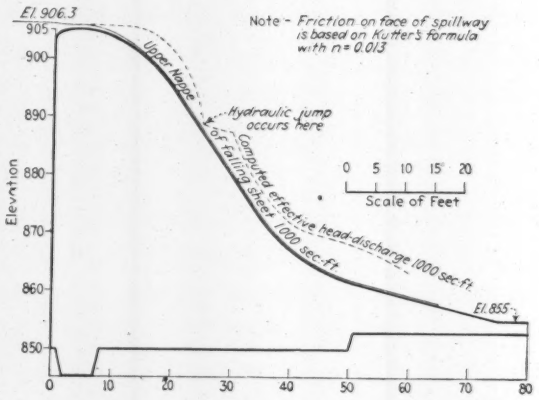


FIG. 1—HYDRAULIC PUMP UNDER LOW HEAD
Computed position of hydraulic pump upon face of ogee overfall dam with head of 1.3 ft. on crest.

2. *Baffle Blocks on Bucket of Ogee:*

Examples: Applied to the Bassano dam by John R. Freeman and described in Vol. 80, *Transactions*, Am.Soc.C.E., p. 338 (1916), by K. R. Kennison, and *ibid.*, p. 363, by H. B. Muckleston.

Cheoah dam, on the Little Tennessee River, described in Vol. 97, *Engineering News-Record*, p. 800 (Nov. 11, 1926), by R. F. Ewald.

3. *Baffle Piers on Apron:*

Examples: Gatun dam; photo under one condition of operation shown *ibid.*, p. 801.

Pit River dams Nos. 3 and 4; experiments and actual construction described by I. C. Steele, Vol. 96, *Engineering News-Record*, p. 886 (June 3, 1926), and by I. C. Steele and R. A. Monroe, *Proceedings*, Am.Soc.C.E., November, 1927, p. 2189.

4. *"Toe-Pool":*

A pocket below apron level at toe of dam to receive and reflect the falling sheet.

Example: Nepaug dam of the Hartford, Conn., water-works, described by F. P. Stearns, Vol. 80, *Transactions*, Am.Soc.C.E., p. 367 (1916), and by C. M. Saville, *ibid.*, p. 405.

Variations on this idea are discussed in an article entitled "High Velocity Discharge of Overfall Dams and Forms of Spillway Profile," by Adolph F. Meyer, Vol. 93, *Engineering News-Record*, p. 597 (April 9, 1925).

5. *"Tumble-Bay":*

A pool of greater length and depth formed below the dam by a weir or by depression of the apron, or both.

Examples: Applied to the Manistee River dam by the Fargo Engineering Company, described by Joel D. Justin and by Horace S. Hunt in Vol. 94, *Engineering News-Record*, p. 945 (June 4, 1925).

Experimented upon and applied in combination with baffle piers to Pit River dam No. 4, to which reference appears under paragraph 3.

6. *"French Type":*

V-shaped depression at toe of dam formed by sloping the apron down from the level of the channel bottom to intersect the downstream face of dam substantially at right angles and thus take the full shock of the falling sheet.

Described by M. Suquet, Vol. 94, *Engineering News-Record*, p. 866 (May 7, 1925).

Experiments reported upon by Steele and Monroe, reference under paragraph 3.

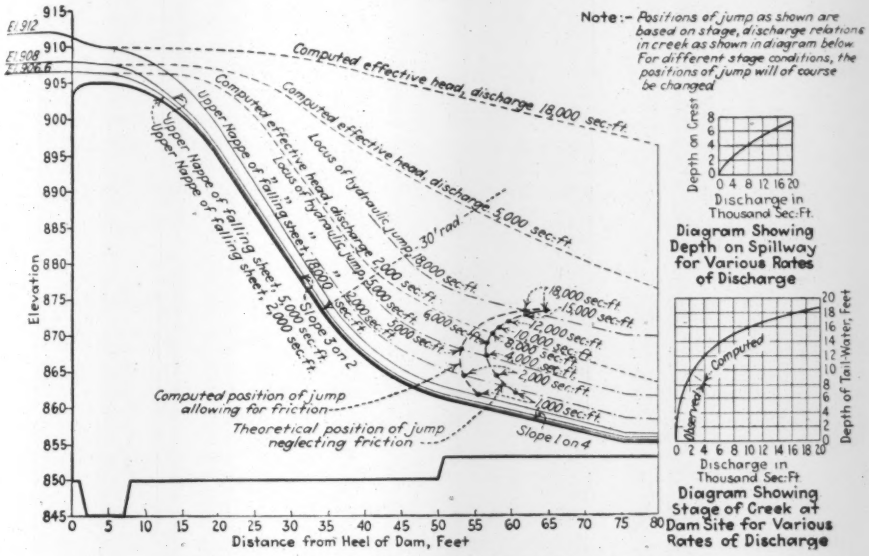

Note:- Positions of jump as shown are based on stage, discharge relations in creek as shown in diagram below. For different stage conditions, the positions of jump will of course be changed
Computed effective head, discharge 18,000 sec.-ft.
Computed effective head, discharge 15,000 sec.-ft.
Computed effective head, discharge 2,000 sec.-ft.
Locus of hydraulic jump, 18,000 sec.-ft.
Locus of hydraulic jump, 15,000 sec.-ft.
Locus of hydraulic jump, 2,000 sec.-ft.
Upper Nappe of falling sheet, 18,000 sec.-ft.
Upper Nappe of falling sheet, 15,000 sec.-ft.
Upper Nappe of falling sheet, 2,000 sec.-ft.
30' rad
Slope 3 on 2
18,000 sec.-ft
15,000 sec.-ft
12,000 sec.-ft
10,000 sec.-ft
8,000 sec.-ft
6,000 sec.-ft
4,000 sec.-ft
2,000 sec.-ft
1,000 sec.-ft
Computed position of jump allowing for friction
Theoretical position of jump neglecting friction
Slope 1 on 4
Elevation
Distance from Heel of Dam, Feet
El. 912
El. 908
El. 906.6
Depth on Crest
Discharge in Thousand Sec.-Ft.
Diagram Showing Depth on Spillway for Various Rates of Discharge
Observed
Computed
Depth of Tail-Water, Feet
Diagram Showing Stage of Creek at Dam Site for Various Rates of Discharge

FIG. 2—SPILLWAY WITH INCLINED APRON
Computed position of hydraulic pump at various rates of discharge.

7. *"Aerial Jump":*

After passing smoothly over the dam and while traveling horizontally on the apron in a thin sheet at high velocity, the water is deflected upward by piers of weirs with sloping faces to follow a parabolic trajectory through the air and fall into the channel some distance downstream.

Example: Experiments for and application to the Bull Run dam of Portland, Ore., water supply, described by D. C. Henny, Vol. 98, *Engineering News-Record*, p. 842 (May 26, 1927).

Experiments also made by the Miami Conservancy District.

8. *Confined True Hydraulic Jump:*

Example: The Willwood dam of the Shoshone project of the U. S. Bureau of Reclamation, described by Ivan E. Houk, Vol. 99, *Engineering News-Record*, p. 660 (Oct. 27, 1927), is reported to hold a smooth hydraulic jump close to the toe of the dam by means of depressing the curved bucket of the ordinary ogee section to meet the apron at a point sufficiently below channel bottom to give the depth required to form the jump, with apron thence sloping gently upward to meet the channel bottom.

Design for the Mineral Ridge Dam — The Mineral Ridge dam is proposed by the Mahoning Valley Sanitary District in connection with the development of a water supply for the cities of Youngstown and Niles, Ohio. The spillway will be 50 ft. high above streambed in shale and thin-bedded sandstone, with a net length of 260 ft. It is designed to discharge a flood flow of 18,000 sec.-ft. with 7 ft. depth of water over the crest. The selected spillway section is of the massive concrete ogee type with inclined apron so designed as to cause the hydraulic jump to occur upon it. A low weir is located at the estimated downstream end of the jump.

Fig. 2 shows the outline of the spillway section and diagram giving the stages of headwater and tailwater for the expected range of discharge. At all stages the natural tailwater level is too high to permit the occurrence of the hydraulic jump on an apron at streambed level. The figure shows the computed locus of the beginning of the jump on the inclined apron as governed by the natural tailwater conditions for the full range of discharge on two different bases:

1. Theoretical position neglecting friction of the overfalling sheet of water upon the face of the spillway.

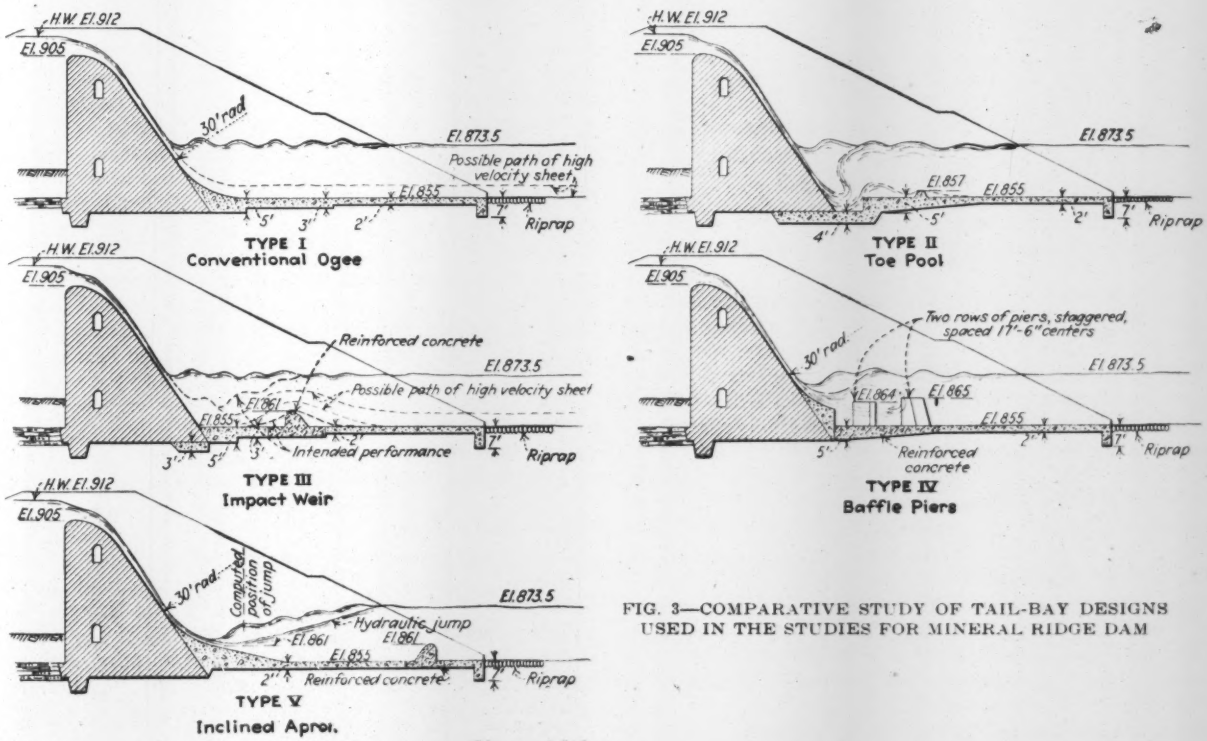


FIG. 3—COMPARATIVE STUDY OF TAIL-BAY DESIGNS USED IN THE STUDIES FOR MINERAL RIDGE DAM

2. With allowance for such friction on the basis of the Kutter formula with $n = 0.013$.

Such friction allowance is of course approximate only, as experimental data are lacking. It is, however, interesting to note in Fig. 1 that on this basis of estimating a hydraulic jump should occur on the steeply sloping face of the spillway at a point about 17 ft. below the crest when discharging under a head of 1.3 ft. This phenomenon does occur on all ogee dams when discharging under low heads, as evidenced by the "white water" seen at such times and excellently illustrated in the illustration of the Willwood dam on p. 661 of *Engineering News-Record* of Oct. 27, 1927. A single observation made on the Lake Rockwell dam of the Akron, Ohio, water supply, on Dec. 2, 1927, while discharging under a head of 1.2 ft., showed the jump on the smooth concrete face of the dam at a point 13 ft. below the level of the crest.

A series of observations as to the exact position of this jump under stated discharges would furnish the fundamental data from which the friction coefficient of the falling sheet on the face of the spillway could be accurately determined.

The accompanying table shows a comparison of the relative costs and advantages of various types of tail-bay designs considered with a view to preventing erosion in the channel below Mineral Ridge dam. The types indicated are those shown in section in Fig. 3. Of the five types shown, the conventional ogee spillway is taken as the basis in determining the additional cost of the several tail bays used in the studies. From a comparison of the advantages and disadvantages there shown it is believed that the merits of the inclined apron for producing a controlled hydraulic jump are made plain.

W. H. Dittoe is chief engineer of the Mahoning Valley Sanitary District and the author of this paper is deputy chief engineer.

Compressed Air Blows Top Off Pneumatic Caisson

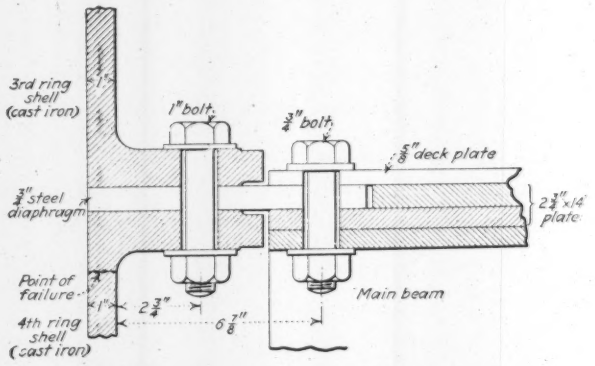
Steel-Plate Deck Bolted Between Flanges of Two Lining Rings Puts Dangerous Bending Strain on Cast-Iron Shell

AIR PRESSURE burst out the deck of a pneumatic caisson for a tunnel shaft being sunk at Deptford Green, London, England, in January, 1927. Five lives were lost in the explosion, which completely wrecked the upper part of the caisson cylinder. According to the report of the British Home Office engineers, the shaft, 20 ft. in diameter, was started by open excavation, but water encountered 20 ft. below the surface necessitated the use of air from then on. Cast-iron lining was used, made up in sections, twelve to a ring, each ring 3 ft. in depth. The sections were bolted together through flanges at the top, bottom and sides, each section breaking vertical joints with the one above. Grout was forced through a 1½-in. hole in the center of each section to fill the space between the excavation and the lining.

To convert the open well into an air caisson, a steel deck was built between the third and fourth lining rings. The deck consisted of ⅝-in. plates, stiffened with four parallel I-beams, two beams being placed 3 ft. and 8 ft., respectively, one each side of a diameter. The four beams were connected at the top by channels, but were not cross-braced. This deck was connected to the shell by a ¾x9½-in. steel diaphragm built in the horizontal joint between the two lining rings. A detail of this connection is shown in the accompanying illustration.

The explosion occurred late one afternoon, throwing the deck and the three shell rings above it far into the air. Part of the débris, falling back into the pit, caused the death of the workmen. The explosion left a clean horizontal break in the shell just below the upper flange of the fourth ring.

A careful study of the circumstantial evidence proved that no violent internal explosion had taken place. Therefore the investigation turned to the caisson design, which showed that the apparently safe steel deck connection was subjected to far greater stresses than was ever supposed. Reference to the illustration shows that the deck proper is bolted to a steel ring placed between the horizontal flanges of two lining rings. Circumferentially the lining was subjected to a tensile stress of 1,500 lb. per sq.in. in a horizontal plane. The direct vertical tensile stress in the lining amounted to only 500 lb. per sq.in. with the air pressure at its highest. Neither of these stresses is alarming in cast iron. However, the upward thrust of the deck produced a bending moment in the connecting steel ring, which was transferred through the horizontal flanges to the comparatively thin cast-iron shell. The steel ring, having an even bearing against the flange above it, transferred the pressure to the flange evenly. The same pressure, or tendency to bend, occurred in the flange just below the ring, but was transferred to this flange through the connecting bolts, which concentrated the load at several points. Furthermore, the two main deck stiffening beams reached the wall at points between vertical flanges. As the deck pressures were undoubtedly concentrated somewhat at these beam ends, this threw further concentrated stresses into the walls.



DETAIL OF DECK CONNECTION TO CAISSON SHELL

Therefore, it is assumed, the wall was ruptured first by a local combined bending and tensile failure at one of these concentration points. The failure then spread out to neighboring sections until the entire wall gave way. It is contended that if the beam ends had been placed under vertical flanges in the sections above, the failure probably never would have occurred.

The investigation for the Home Office was made by R. V. Shaxby, L. C. McNair and W. L. Lowe-Brown, and their full report is printed as Report 1853 of the Home Office. The shaft was being built in connection with an intake tunnel for a generating station of the London Power Company, Ltd., by the Foundation Company, Ltd., of London, England.

Earthquake-Resistant Construction
II—Principles of Design

Naito's Methods of Design—High Office Buildings—Construction With Flexible First Story—Wall Strength—Some Basic Considerations in Design—Steel Versus Concrete—Building Law Provisions—Conclusions

By Henry D. Dewell
Consulting Engineer, San Francisco

Concluding the study begun in *Engineering News-Record* of April 26, 1928, p. 650, the author now discusses specific methods of design, first of buildings less than twelve stories and then of high city buildings. Fully rigid construction is held to be practicable for the former, but may not be feasible for high buildings. The system of construction with flexible first story is described, but its efficacy is questioned. General rules and cautions are given. For the future the author believes experimental study will prove particularly valuable. —Editor.

Dr. T. NAITO, of Waseda University, Japan, has written a treatise on the design of buildings to resist earthquakes. It claims high authority for the reason, among others, that in the Japanese earthquake of September, 1923, several large buildings designed in accordance with his theories suffered no appreciable earthquake damage. His fundamental principles of design are first, rigidity, and second, the rational distribution of the lateral force to the various bents of a building, including the walls and interior braced partitions which are designed to take their share of the work.

In brief, Dr. Naito holds that for buildings within the maximum height of 100 ft. (and this appears to be the limiting height in Japan) the design should be such as to make the building as rigid as possible. He endeavors to make the natural period of elastic vibration of the building smaller than that of any earthquake of destructive intensity.

Since a building is composed of several vertical structural elements that have varying resistance to lateral deformation, such as walls, framed bents, interior partitions, etc., and since these various elements are generally connected horizontally by monolithic floors of great rigidity, it is evident under the assumption of a rigid floor, an assumption that is substantially correct, that the lateral deflections of all vertical elements due to a lateral force, whether they be interior bents or stiff wall bents, will be equal. Therefore such common deflection will depend upon the total rigidity of all the elements offering resistance to the lateral force. In other words, the sum of all the rigidities of the various bents must be determined, and then the proportion of the total lateral force coming to each bent must be found, based on the ratio of individual rigidity to the total rigidity. Each structural bent must be designed to resist that force.

Practical and relatively simple methods are developed by Dr. Naito for finding the effective rigidities of various types of structural frames, including those with which are incorporated concrete and brick walls, with and without openings. This method of proportioning the various bents is logical and is as applicable to the case of wind loads as to earthquake force. The ordinary method of computing wind stresses, which assumes that an interior bent of a building takes a wind load proportional to its tributary wall surfaces, is illogical and incorrect. That it leads to gross errors has apparently not been generally realized, for such method has been generally employed. A similar comment may be made on another method, sometimes employed, of arbitrarily selecting and using certain convenient bents to furnish all the resistance to wind, without consideration of their rigidities.

As an illustration of the effect of consideration of the probable respective rigidities, the case may be cited of a seven-story-and-basement concrete loft building, 110x128 ft. in plan. The relative proportions of an assumed lateral force taken by a wall bent and an interior bent were found to be 8 to 1.

From what has been said it is obviously advantageous to utilize any lines of interior partitions, court walls, etc., that can be made to accommodate rigid bents. Such opportunities for stiff bracing should be utilized. Dr. Naito points out that solid walls and diagonal bracing are most efficacious and that the rectangular paneled frame, which must resist distortion through bending in its component beams and columns, is an uneconomical method of framing for resistance to lateral forces. These considerations are, of course, as true for resistance to wind as for resistance to earthquake shock.

Other recommendations made by Dr. Naito are: (1) That reinforced-concrete walls, particularly with diagonal reinforcing, be used when possible; (2) that the corner bays of buildings have as few openings as possible; (3) that the full depth of wall spandrel sections be utilized as beams; (4) that structural steel wall columns of I and H shape have their webs always placed parallel with the walls; (5) that end restraint additional to that furnished by their connections to columns be given the beams on column center lines, by means of extra reinforcing bars in the concrete floor slab across the columns; (6) that horizontal diagonal bracing be used between the floor beams attaching to an interior column; (7) that particular attention be given the corner wall columns of a building, because such columns act as flanges of the vertical cantilever beams represented by the walls, and hence will carry heavy direct stress in an earthquake; (8) that for a similar reason, ample area to carry these column loads be given the footings of such corner columns, and (9) that foundation footings be well tied together.

With the exception of wall bents and certain special interior bracing bents, the structural frame will be but little heavier than that required by the dead and live loads.

The writer is convinced that the utmost rigidity for buildings is a desideratum. The utilization of the walls and of such interior partitions as are available for bracing is a relatively inexpensive way of securing the desired rigidity and strength and consequently immunity from earthquake damage. This statement is not to be under-

stood as implying that any building may be given reasonable safety against damage from a major earthquake at no increased cost over a design for the ordinary dead and live loads. Such is not the case. But the time has come when it is profitable for the owner to spend money to give his building safety against earthquake shock and to sacrifice desirable architectural features to enable the engineer to brace the building effectively. The conditions of financing and insurance already impose this requirement.

High Office Buildings

Coming to the consideration of high office buildings—that is, buildings of twelve to 40 stories and more—we have but little precedent to guide us. Such high buildings do not exist in Japan. In San Francisco in 1906 the highest buildings were about eighteen stories. These buildings, with steel frames, concrete floors and curtain walls of brick and stone facing backed with brick masonry, apparently suffered no serious damage to their frames from the earthquake. There were no reinforced-concrete buildings. In a number of steel-frame office buildings, curtain walls were cracked in some stories, and joints of stone facing opened.

The Claus Spreckels Building, nineteen stories high and located in a region suffering an estimated acceleration of from $\frac{1}{2}$ to $2\frac{1}{2}$ ft./sec.^{2}, was found to have a period of vibration of $2\frac{1}{3}$ seconds, this period having been measured six years after the earthquake. The building is of particular interest, since its frame was designed for a 50-lb. wind pressure because of the probability of earthquake (see *Engineering Record*, Vol. 37, Nos. 19 and 20, 1918). Due to the fact that such design was probably made with no regard to relative rigidities of the various structural units, it is almost certain that the frame did not act in the earthquake as assumed—that is, it is not likely that the distribution of actual unit stresses under wind pressure was as assumed, but that the exterior wall frames took the brunt of the shock.

Flexible First Story

Mention has already been made of the opinion of some engineers that the proper type of earthquake-resistant design for a high building is that in which the first-story columns are designed to offer flexibility, in connection with a rigid superstructure. Arguments for this type of design have attained particular prominence since the Santa Barbara earthquake. Recently there have been constructed in the vicinity of San Francisco three steel-frame office buildings that are claimed by their designers to conform to the examples of this type of construction.

The requirements of such a design, as set forth by one of these engineers, are as follows: A high first story, with the first-story columns slender enough to take a horizontal movement of about $1\frac{1}{2}$ in. without overstrain, is the primary requirement. In the event that the necessary height for flexibility (which is placed at about 25 ft. for steel columns and 35 ft. for concrete columns) cannot be provided in the first story, then the connections of mezzanine or second-story beams to the columns are to be so designed that they will, in effect, approximate hinges. The beam connections at the top of the flexible length of columns are also to be of such design that, while assuring strength for vertical loads, they will give sufficient flexibility to allow the necessary yielding of columns. In the ideal case, such flexible columns are to be entirely disconnected from the first-story walls and piers, and a horizontal wall joint is to be provided just below the second-floor beams. The upper part of the building—that is, the portion above the flexible columns—is to be made rigid. It is then expected that no damage will result to this upper portion during a severe earthquake; that all damage will be confined to the first story, and that such damage will be relatively small and easily repaired.

All of the three buildings referred to are on corner lots and therefore have two street fronts, with resulting small wall areas on these faces. In one building the first-story rear walls are made of hollow tile. These are expected to crack in the first heavy shock and thus cease to give any stiffness to the building. It is held that in the succeeding vibrations the building will act in the manner described. In one of the other buildings, the first-story portion, while unusually high (34 ft.), has a much larger area than the upper portion. The two rear walls are of solid reinforced concrete, while masonry piers of some size surround all street wall columns.

The arguments for this type of design are worthy of careful study. Whether these buildings, as actually constructed, will fulfill the ideal conditions and whether they will act as assumed in the design is, in the writer's opinion, very doubtful. The effect of the first-story walls and piers on the stiffness of the building cannot be ignored. In no one of the buildings are the first-story columns disconnected from the walls, nor is there a wall joint under the second-floor beams. The assumed rigidity of the upper portions of the buildings is also open to question. In one case these walls are of reinforced concrete; in the other the walls are of brick.

Effect on Upper Stories

When the first-story walls and piers of buildings of this type have once ruptured, it is probable that the effect of the earthquake on the upper stories will be lessened. Such action appears to have taken place in the Carrillo Hotel, Santa Barbara. Nevertheless, the writer feels that probably in some if not all cases of such design the lower-story walls and piers will offer sufficient rigidity to allow walls and partitions of some of the upper stories to rupture. It seems to him also probable that buildings so designed will suffer cracked walls and partitions in minor shocks, which are relatively frequent in seismically active regions. The Carrillo Hotel, mentioned above, has suffered severe cracking in its first-story walls, piers and interior partitions in earthquakes subsequent to that of June 29, 1925, and of much less intensity. Finally, it must be remarked that this theory apparently takes no account of possible resonance between the period of the building and a succession of constant periods of the earthquake.

To summarize the situation with respect to the design of high office buildings, we must frankly admit that at the present time engineers are not in accord with respect to the probable earthquake damage. There is a real question as to whether it is feasible to make such buildings earthquake proof. The writer believes that those buildings which have a good steel frame, conservatively designed, are safe from danger of collapse, but that in a destructive shock they will suffer very considerable damage to walls and interior partitions in certain stories—that is, in all cases where the work is thrown mainly on the frame and where the walls are carried merely as an extra load.

The writer holds that the structural frame with brick

or tile curtain walls laid up between the beams and columns is far inferior in strength to the frame with reinforced-concrete walls. This belief is corroborated by Naito, who advocates brick walls only in the upper stories of his very rigid buildings. If the frame is not adequately stiff, its walls will be cracked and crushed in those panels where there is notable distortion. Since the wall with its frame acts as a vertical beam resisting bending from horizontal loading, the horizontal shear due to the earthquake induces tension and compression on planes at 45 deg. with the vertical. Again, since the earthquake force is oscillating, tension and compression will occur alternately on diagonal planes. Any material that cannot withstand such tension must crack; hence the X-cracks in walls approximately parallel to the planes of the earthquake vibrations, which have been evinced in all heavy earthquakes. The remedy is to introduce adequate tensile strength.

Fundamentals of Design

Certain essential features of earthquake-resistant construction which are generally recognized by those who have given study to the subject will be set forth. These are applicable to all types of buildings.

Location—Disadvantageous locations are (1) proximity to an active fault plane, (2) made or marshy land and (3) the junction between soils which would act differently in an earthquake shock, as the top of a bluff or the bottom of a slope. Conversely, a location at some distance from the active fault plane, and on hard rock or good firm deep soil, with approximately level surface, is most advantageous.

Shape of Building—The building that is "closed" in plan, as a hollow or solid rectangle, is best from the standpoint of seismic risk. Buildings of L or U shape are at a disadvantage in an earthquake, for the component parts will likely have different vibration periods, resulting in heavy stresses at the junction of the parts. Finally, uniformity as opposed to irregularity of height is a desideratum.

Foundations—Deep foundations are a valuable asset in an earthquake. Foundations should be substantial in design and well tied together. All concrete foundations should be well reinforced, and the reinforcing from one unit should be carried well into connecting units. High soil pressures should be avoided, and particular attention should be given to the corner piers, to give them ample bearing area against the earthquake effects which are there concentrated.

Superstructure—The superstructure should be built to give, in effect, a unit mass against earthquake. Rigidity is essential. Full diagonal bracing should be used when possible, and deep kneebracing when openings will not permit full diagonals. The walls should be carefully designed, heavily reinforced around openings, which should be as few as possible. Solid panels on either side of a corner add great resistance to the wall. Veneers of stone or brick should be avoided, but if absolutely necessary should be thoroughly tied and anchored to a rigid backing.

General—Buildings with towers or heavy cornices and buildings with very unequal distribution of mass are at a decided disadvantage in an earthquake. The various units, having different natural periods of vibration, tend to batter against one another; the result is almost certain destruction, unless these units are properly framed to resist such action.

Buildings or parts of a building that are in contact but not bonded firmly together may sway with different periods. In that case they are likely to separate and come together again with some degree of violence, sufficient to destroy them. It is therefore important that structures should be symmetrical in design and in distribution of weight. Where that ideal is impracticable, the unsymmetrical sections should be firmly tied together so that they will swing as a unit, or else they should be separated beyond the range of collision and connected (where connection is necessary) only by lighter and more fragile structures in which damage may be safely and economically concentrated.

Steel Vs. Concrete

Much has been written concerning the relative value of structural steel and reinforced concrete as furnishing resistance, this being a controversial subject among builders. For buildings of moderate height, reinforced concrete properly designed and honestly constructed will furnish resistance to earthquake shock, as has been proved by experience. The danger lies in improper design and improper construction, particularly the latter. It can hardly be denied that with a steel-frame building there is less chance of improper workmanship that would seriously weaken the frame than with reinforced concrete. There is no record of the collapse in an earthquake of a building with a complete structural frame carrying walls, floors and roof, although records of Tokyo in 1923 and of Miami in the tornado of 1926 have shown that a steel frame may suffer terrific damage when constructed too lightly. Reinforced concrete has not proved so reliable. Conservative design would, then, indicate a moderate height for reinforced-concrete buildings to be located in districts subject to earthquakes.

Building Law Provisions

Until very recently no American city has recognized the necessity of making provision in its building ordinances against earthquakes to the extent of definitely mentioning earthquake shock. San Francisco, in framing its new building ordinance in 1907 after the disaster of 1906, made a purposely indirect provision against earthquakes by specifying a 30-lb. wind pressure for certain types and sizes of buildings. Subsequently this specified unit wind pressure was reduced to 20 lb. per sq.ft. and finally to 15 lb. per sq.ft., the present specification.

After the Santa Barbara earthquake of 1925, Santa Barbara and Palo Alto made definite provisions in their building laws for design against shock. Sacramento has adopted similar clauses, so that the building laws of three California cities now require definite design against earthquakes. The nature of these provisions will be indicated by the following extracts from the building laws of two cities.

Santa Barbara

Wind and Shock Bracing

A. All buildings and structures shall be built so as to resist wind loads, shocks and vibrations by one of the following methods:

1. Rigid connections at the intersection of beams, girders, floor systems and roof trusses with their supports;
2. By means of knee or diagonal bracing, or
3. By bracing in walls.

B. All buildings not having inherent stability in their structural design equal to the bracing herein required shall be braced to resist a horizontal thrust acting in any direction. This bracing shall be applied at all points of support in such a manner that each tier of columns or stories shall resist a horizontal thrust applied to the center of gravity of the supported load equal to 10 per cent of the load which they support when the foundation rests on material

upon which a bearing of 4 tons per square foot is allowed; 15 per cent when 3 tons per square foot is allowed, and 20 per cent when less than 2 tons per square foot is allowed or when piling or raft foundation is used.

C. All buildings and structures hereafter erected having large open spaces therein such as garages, theaters, churches and lodge halls, and those buildings or structures which have rooms or spaces of a width in excess of 35 ft. shall have their roof trusses supported on structural steel or reinforced-concrete columns, and all such roof trusses and columns shall be braced with kneebraces.

D. The wind load on all structures less than 30 ft. high shall be computed as a horizontal force equal to 10 lb. for each square foot of surface exposed by a horizontal projection of the building or structure. The wind load on higher buildings shall be computed at 15 lb. per square foot acting on an area equal to the horizontal projection of the said building or structure.

Sacramento

Earthquake Provisions

Sec. 2512. (*a*) Lateral bracing—All framed buildings shall be braced to resist lateral stresses which shall be calculated by two independent methods and that one of the calculations which calls for the stronger structure shall be used in the design and construction. By the first method the stresses shall be calculated as the effects of a pressure applied horizontally to the elevation of the building above foundation, figured in pounds per square foot of area as hereinafter specified. By the second method the stresses shall be calculated as the effects of a force applied horizontally at the center of gravity of the dead load. In both methods of calculation the pressure or force, as the case may be, shall be assumed to come from any possible direction at right angles to any elevation of the building.

The factors to be employed to fix the pressure per square foot of area on the side above the foundation or the lateral force applied at the center of gravity shall vary with the character of the foundation material and shall be as follows:

1. When the foundation rests upon material upon which a load of 4 tons per square foot is allowed, the lateral pressure employed in the first method shall be assumed as equivalent to 20 lb. per square foot; in applying the second method the horizontal force applied at the center of gravity shall be assumed as 10 per cent of the load upon the columns.

2. When the foundation rests upon material upon which a load of 3 tons per square foot is allowed, the lateral pressure employed in the first method shall be assumed as equivalent to 30 lb. per square foot; in applying the second method the horizontal force applied at the center of gravity shall be assumed as 15 per cent of the load upon the columns.

3. When the foundation rests upon material upon which a load of 2 tons per square foot is allowed, the lateral pressure employed in the first method shall be assumed as equivalent to 45 lb. per square foot; in applying the second method the horizontal force applied at the center of gravity shall be assumed as 20 per cent of the load upon the columns.

Conclusions

While there is yet much to be learned concerning the nature of earthquakes and of the effects of earthquakes on structures, much progress has been made, and the writer believes that the time is not far distant when there will be general agreement on the part of structural engineers with respect to the proper methods of design for resistance to earthquakes. For buildings of relatively low height, safe design, both from the standpoint of property damage and injury to people, is practicable and relatively inexpensive. For the very high buildings, especially those of slender proportions, the question of proper design and probable damage is still controversial.

Experimental work is badly needed. It is feasible to learn much by use of a shaking table and scale models of typical structures. Omori's experiments with a shaking table driven by a steam engine, on which he tested columns of brick masonry and other material, are classic in seismological circles, and his results have been widely quoted and used. Yet Omori's experiments are crude when compared with what might now be accomplished by making use of the modern instruments for measuring stresses and by the use of the motion picture camera. Stanford University has undertaken such a research program and has now in operation a large shaking table.

There is great need for seismographs of special design to be located in the business districts of large cities in regions that are known to be seismically active. These instruments should be so constructed that, while incapable of being affected by street traffic, they would be able to record completely the heaviest earthquake shocks. Only by such experiments can the damage to modern buildings by earthquake be correctly correlated with the actual periods, amplitudes and accelerations of the shock producing such damage.

The possibilities of earthquake-resistant construction are becoming more and more appreciated, particularly as the rates of earthquake insurance are rising, together with restrictive clauses of the policies and the evident desire of the insurance companies to avoid the risks.

Finally, lest the reader gain the impression from this paper that California alone has seismic risk, let the following earthquakes of major intensity be called to mind: New England in 1638, the St. Lawrence Valley in 1663 and 1925, Boston in 1755, New Madrid, Mo., in 1811, Charleston, S. C., in 1886, and Montana in 1925.

Irrigation Scheme Near Mexican Border

Construction of a high dam of the buttress and slab type of reinforced concrete, as noted in *Engineering News-Record,* March 22, 1928, p. 492, is to be the first step in a large irrigation scheme in Lower California across the border from San Diego. The work is to be carried out under the direction of Gen. A. L. Rodriguez, Governor of the northern district of Baja California, pursuant to the recently adopted policy of the Mexican government of placing large tracts of land in widely scattered areas under irrigation. Following the construction of the dam which is now under contract on the Tia Juana River, it is expected that the government will undertake the development of the adjoining watershed of the Tecate River. It is also the purpose of the government to develop the San Quentin irrigation project, about 200 miles south of San Diego, originally undertaken by an English syndicate in 1886, placing water on about 70,000 acres of land. This region probably will be developed along the lines of a report made to the government of Lower California in 1926 by the J. G. White Engineering Corporation. The total irrigation program will cost about $12,500,000.

Charles P. Williams, formerly consulting engineer for the United States Reclamation Bureau, is associated with this irrigation project in an advisory capacity on behalf of the Mexican Irrigation Commission. Following his examination of the site of the proposed dam and that of the Ambursen Construction Company, the contractor for the new dam, a buttress and slab type of dam was adopted. The foundation rock is badly shattered and sound rock can be found only at a considerable distance below the surface. The dam will be 255 ft. high from the bed of river to the crest of the bulkhead section. The cost is estimated at $3,000,000. Work will be commenced immediately, as it is intended to have water on the land within two years, whereupon the extensions of the project will be placed under construction.

Outlook for Production of Ties

In this article in *Engineering News-Record* of April 5, p. 560, the credit line had a typographical error. The author is E. E. Pershall, vice-president of the T. J. Moss Tie Company, St. Louis, Mo.

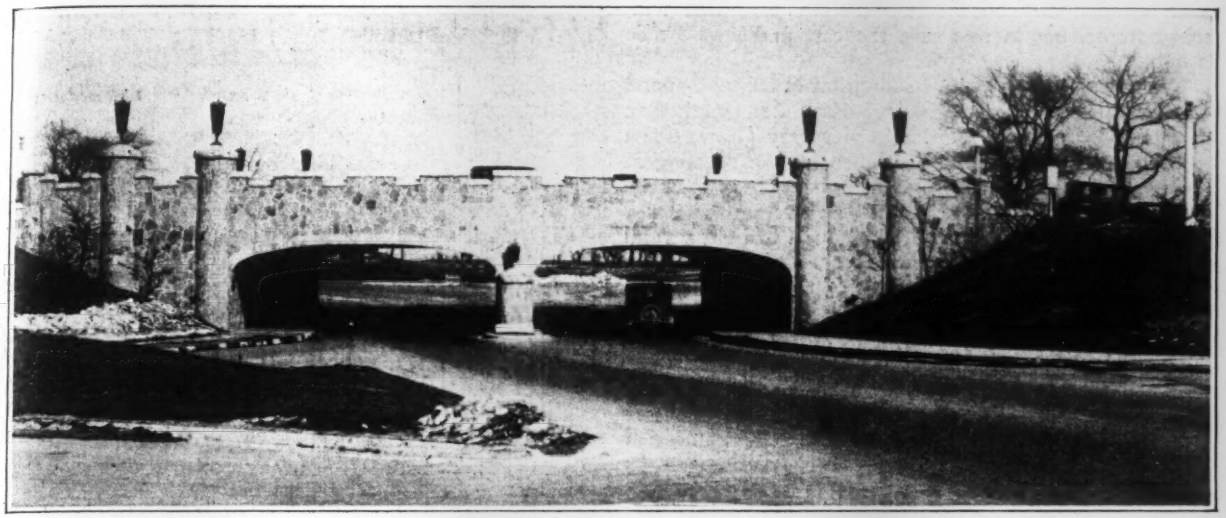


FIG. 1—STOCKTON DRIVE SUBWAY UNDER LAKE SHORE DRIVE

Highway Grade Separation in Chicago Park

Route of Fast and Heavy Automobile Traffic Is Cleared of Cross and Diverging Cars—Easy Curves and Grades Aid Movements of Vehicles

GRADE separations at highway crossings, to facilitate traffic movements and eliminate a serious source of delay and danger, may be especially important in and near cities, where a heavy and regular suburban traffic enters into consideration. An interesting case of this kind is in Lincoln Park, Chicago, where the Lake Shore Drive is estimated to carry about 20,000 automobiles south to the business district every morning and north to the residence districts and suburbs in the evening. Three such separations of grades were built in 1927 on the Lake Shore Drive in a distance of 3½ miles, and two more are planned farther north on a new extension of the park.

At the south entrance to the park, North Ave. terminates by a junction with the Lake Shore Drive, and with the Stockton Drive across the south end of the park, so that formerly there was considerable interruption to the main traffic movement north and south by vehicles entering or leaving laterally at North Ave. This situation has been relieved by diverting lateral traffic to the Stockton Drive, which is carried under the main driveway but is connected with it by means of curved inclined drives or swing drives. This arrangement is shown in Figs. 2 and 5. Here the Lake Shore Drive, 80 ft. wide, is elevated and carried over the depressed low-level Stockton Drive by a bridge. North of the bridge the roadway forks, the main Lake Shore Drive swinging a little to the west, whereas the Beach Drive swings east and follows along the Lake Michigan shore for a considerable distance. Both of these drives are 45 ft. wide.

An unusual arrangement, due to the heavy traffic of the rush hours, is that the upper level over the bridge is used almost exclusively for southbound vehicles in the morning and for northbound vehicles in the evening. At these times much of the lighter traffic that is proceeding in the opposite direction takes the course of least resistance by going to the east and west swing drives respectively.

Only right-hand turns are permitted within the grade separation zone. At North Ave., however, a left-hand turn is necessary for cars running north and turning west, since the cross street does not continue east of the drive. With an intersection instead of a closed end, as at Irving Park Boulevard, shown in Fig. 3, a car has to make a right-hand turn into the cross street and then turn in this street in order to move westward through the subway. Eastbound cars to go north should go under the bridge and make two right-hand turns and then go over the bridge. Many drivers, however, prefer to make one left-hand turn from east to north, as being

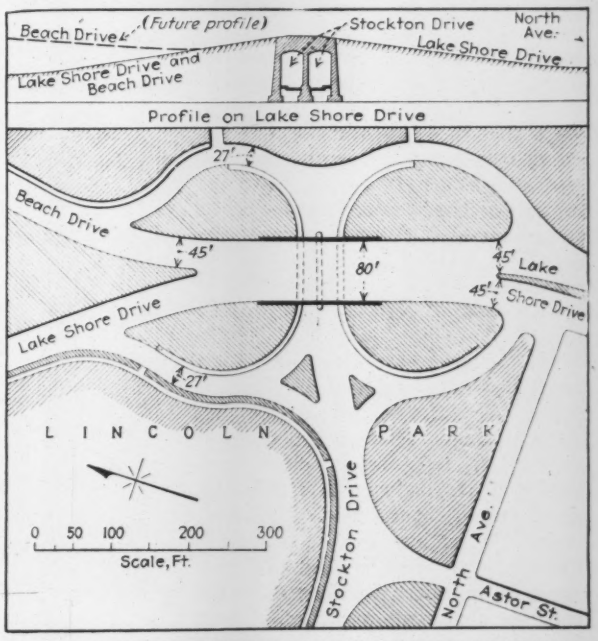


FIG. 2—GRADE SEPARATION AT STUB-END STREET

more convenient. This would not be permitted with heavy traffic, but in this case the east and west traffic is light.

The other crossings differ somewhat in being diamond shaped with straight swing drives of greater length than those at North Ave., in order to give easy grades down to the cross streets. This is shown by the crossing at Irving Park Boulevard, Fig. 3. The grades in these diamond crossings do not exceed an average of 2 per cent. All swing drives are long enough to hold several cars, so that if movements are checked temporarily the rear cars will not block the stream of traffic on the main drive.

On the main drive, beginning at North Ave., Fig. 2, the ascending grade begins at 1.5 per cent and increases to 2 and then to 3 per cent, with an average of 2 per

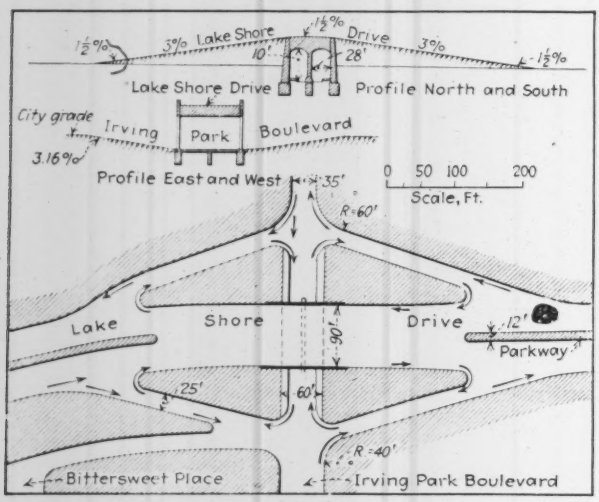


FIG. 3—GRADE SEPARATION AT THROUGH STREET

cent. This continues for about 300 ft. to the middle of the bridge and then descends in the same manner to the park level. From the fork, however, the east or Beach Drive will be changed eventually to rise again at 2½ per cent to a bridge over a channel from Lake Michigan to a park lagoon, beyond which it will drop at 1½ per cent to the park level.

On the cross road, Stockton Drive, the descending grade begins at 1 per cent and is then 1.63 per cent to the subway. The connecting loops or swing drives, 27 ft. wide, have grades mainly 1 and 1.6 per cent, with a maximum of 2 per cent. These curved swing drives have radii of 80 to 120 ft.

All the bridges are of the design and construction shown in Figs. 1 and 4, but differ slightly in the masonry facing. There are two openings 28 ft. wide in the clear, each with a 19-ft. roadway, 8-ft. sidewalk and 1-ft. curb at the pier. The headroom for roadway is 10 ft. Each opening is spanned by 20-in. I-beams about 28 in. apart, which rest on the concrete abutments and pier. These beams are embedded in a concrete slab, which is 26 in. thick at midspan

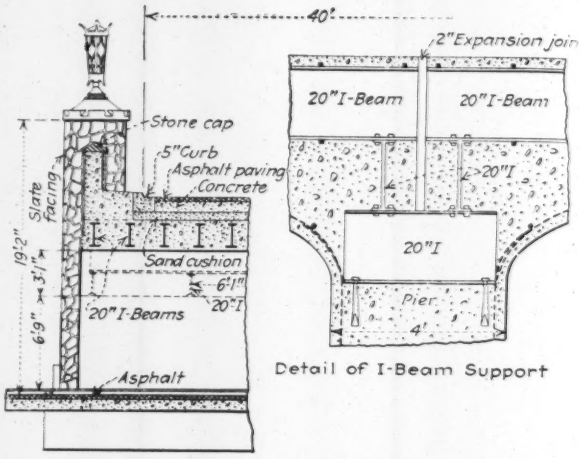


FIG. 4—TYPICAL SUBWAY CONSTRUCTION

and has its lower face curved to an elliptical arch. This slab is also carried up to form the parapet wall. The beams rest on similar I-beams which extend lengthwise of the subway and which are in turn supported at intervals of about 7 ft. by short pieces of I-beams, all embedded in the concrete of pier and abutments. The details are shown in Fig. 4.

Upon the concrete slab is a sand cushion 8 in. deep at middle of roadway and dressed to the required transverse crown of the roadway. This cushion is covered with a 9-in. concrete base with 3½-in. top surface of asphalt and binder course. The lower roadways and the swing drives have the 9-in. slab and asphalt paving. Arched openings through the center pier are fitted with lamps to light the roadway.

Pedestrians are excluded from this part of the Lake Shore Drive, no sidewalks being provided. Sidewalks are built on the lower level and pedestrians reach the park walks by crossing the swing drives.

These grade separation layouts and structures were designed by H. A. Marbach, chief engineer of the Lincoln Park Commission.

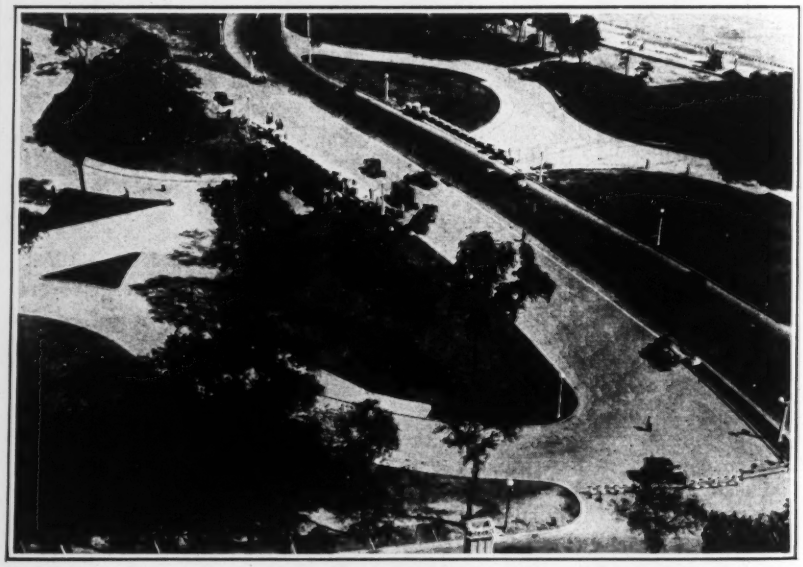


FIG. 5—GRADE SEPARATION IN LINCOLN PARK, CHICAGO
Stockton Drive passes under bridge carrying Lake Shore Drive (left) and Beach Drive (right). Curved drives connect the two levels. North Ave. at bottom, left. Lake Michigan at top, right.

Civil Engineers Meet in Washington

Papers Chiefly Concerned With Engineering Works in Washington—Interest Centers in Construction and Structural Division Meetings and Mapping Exhibit

ACTIVITIES of the American Society of Civil Engineers at its 1928 spring meeting in Washington, D.C., centered on projects of local interest and on some of the governmental activities that concerned the profession. An attendance of 940 was registered, of which approximately 475 were guests. Important parts of the program, in addition to the regular technical sessions, were an excellent student chapter meeting, a visit to the Bureau of Standards, a trip to the city water purification plant, a short address by Herbert Hoover, and an all-day trip to Camp Humphreys, Va., to an exhibition of bridge building and other army engineer activities at that post.

The students' conference was held on Tuesday night, April 24, and was addressed by Robert Ridgway, past-president, Am.Soc.C.E., and chief engineer, Board of Transportation, New York City, on "The Subways of New York City." Student representatives gave short talks on chapter activities, and a general discussion of the subject of student chapters with special regard to society affairs and the profession in general was opened by Willard Chevalier, general manager, *Engineering News-Record.*

At the opening session on the morning of April 25, Lincoln Bush, president, Am.Soc.C.E., introduced Herbert Hoover, who spoke of the widening scope and responsibility that is the civil engineer's. "The day of easy engineering is past," said Mr. Hoover. "Our present problems need vision as never before. They are more and more assuming national significance."

An illustrated address on the work of the Bureau of Standards, given by Dr. Lyman J. Briggs, assistant director, was followed by an inspection trip through the bureau. Several special demonstrations were staged, including a compression test on an H-column section, shearing tests on welded clip angles and burning tests on a fire-resistive shingle roof. Important routine work of the bureau in progress included tests on the many new quick-hardening cements, a determination of wind pressure distribution on an experimental stack 10 ft. in diameter and 30 ft. high, and fatigue tests of duralumin.

Experimental apparatus similar to that now being used for determining wind-pressure distribution (a set of 24 manometer tubes connected to small orifices in the stack) is to be placed 150 ft. off the ground on a new 200-ft. stack which will soon be erected at the bureau's heating plant. This will provide a further series of observations. Unusual interest was shown in the fatigue-testing machine developed by the bureau. In operation the machine bends the specimen back and forth by means of air jets. The specimen is so supported on an air film that there is no physical contact between the specimen and any metal. This machine permits a specimen requiring a vast number of cycles of bending before failure to be tested in two or three hours.

Construction Division

The two papers presented to the Construction Division dealt largely with the use of concrete. The first paper was given by John G. Ahlers, Barney-Ahlers Construction Corporation, New York City, on the subject of "Job Control and Design of a Concrete Mix to Predetermined Strength"; the second paper considered the "Construction Features of the Arlington Memorial Bridge" and was presented by N. H. Crichton, resident engineer.

In presenting his paper on the design of concrete mixtures, Mr. Ahlers by the use of drying pans, scales and cubic measures carried out his field laboratory methods, which he states have resulted in marked economy and predetermined safety for the structures his organization has been erecting during the past two or three years.

Arlington Bridge—The Arlington memorial bridge crossing the Potomac River from Washington to the Virginia side consists of eight reinforced-concrete arches and a structural steel bascule, both the concrete and the steel to be faced with granite, and the whole conceived as one of a series of monuments extending from the capital to Arlington National Cemetery and including so far the Washington Monument and the Lincoln Memorial. Among the construction features of the bridge were the sinking of the series of piers by open cofferdams, the largest of which was 64x140 ft., the grouting of these cofferdams by pipes leading down on the outside, and the tightening of the sheeting above the mud line by the use of hard-burned cinders. The arch barrel of the superstructure is being placed in four ribs of about 23 ft. each. Steel arch-centers for these ribs were floated into place on barges and transferred to ledges on the piers by the combined use of jacks, sea cocks in the barges and the action of the tide.

The half of the bridge from the Washington shore to the bascule span will be constructed this season, the two inner ribs being completed first, after which a derrick will be set up on each pier for placing the outer ribs with their granite facing.

Structural Division

Two papers were presented at the meeting of the Structural Division, one on the repair of the White House roof and the other on the design of the Arlington memorial bridge. In his paper on the Repairs to the White House Roof, U. S. Grant, 3d, director, Public Buildings and Parks of the National Capital, reviewed the history of the White House from the time that it was originally built as a result of a prize offered by George Washington and his commission. James Hoban was the architect who won the competition. The old roof passed through many vicissitudes. Its frame consisted of heavy wooden trusses, the members of which were largely hand hewn. In 1870 warning was given that the floor of the attic had deformed the lower chords, but nothing was done about it. In 1902, when the White House was remodeled and a number of rooms were added in the attic, nothing was done to the roof and although it was re-covered in 1906, the framework was not repaired. Mr. Grant stated that a number of unexpected conditions were encountered which considerably increased the cost of the repair work. For instance, when the weight was taken from the roof trusses they rebounded to such an extent that plaster was torn from the walls of the second floor. Many things had been done to weaken the old framework. In one instance the upper chord had been completely severed to permit an opning in the roof, and

in several cases old wooden gutters were passed through the lower chord, cutting away all but about 4 in. of the effective section of the 12x12-in. timber.

The new construction was erected under a false roof built by the contractor to protect the house after it was exposed. The new roof consists of steel trusses spanning the entire 87 ft. but having intermediate supports on the inner partition walls. Terra cotta arches are used between trusses. Insulating material is applied on the inside, which is believed to have effected some saving in heating costs during the past winter. The outside of the roof is covered with a thin layer of concrete, which is in turn covered with slate. This is a return to the original roof cover, which had been replaced by copper in 1814 and by tin in 1892. The roof as repaired does not in any noticeable way change the appearance of the White House. The new trusses are so arranged that when necessary the second story floor can be hung from them.

The new Arlington bridge, the construction features of which were discussed by the Construction Division, was also the subject of a paper in the Structural Division. In this monumental structure, which is to cost according to latest estimates about $7,250,000, architectural considerations have received unusual attention and in fact account for about 50 per cent of the cost. On the other hand, the structural design of the reinforced-concrete arches and the double leaf bascule span present some interesting features. For instance, the 90-ft. width of the arch barrel requires that continuous cross-walls be used to distribute the load on the backs of the arches, the spandrel walls carrying only their proportionate part. The arch barrel, cross-walls and floor slabs will act as a unit, no expansion joints being provided except at the ends of the arch. The floor is carried over the piers on concrete M-frame bents. While the arches vary in length, they are all designed with the same thickness at corresponding points to assist in construction. John L. Nagle, designing engineer, Arlington Memorial Bridge Commission, who presented the paper, told of his methods of constructing influence lines for bending moment and shear by the aid of calculating machines. In his computations for the arch barrels Mr. Nagle divided the arch into sections of arbitrary length, placing the center of each section at some convenient point, such as, for instance, a point of heavy load concentration.

Prof. George E. Beggs, Princeton University, in an extended discussion of the paper, showed celluloid models of the bridge, one model being the arch barrel itself and the other the arch barrel with the superstructure added. The unusual rigidity offered by the latter arrangement was easily apparent. A hinge placed in the superstructure reduced the rigidity only slightly. Professor Beggs showed moment diagrams of the Grandfrey Viaduct in Switzerland, a high reinforced arch structure in which a remarkable rigidity was obtained by having the superstructure act with the arch rib. Professor Beggs also described a three dimensional model of the Arlington bridge which he had built, about 4½ ft. long, 1½ in. thick at the spring line and with cross-walls about 1½ in. thick, the whole made of celluloid, fastened at the joints with amyl acetate. After suitably loading the model, deflections of the floor both longitudinally and transversely were measured, and the deflections for the completed bridge after spandrel walls were added were estimated. It is hoped that Mr. Nagle will be able to take measurements on the completed structure to check the results obtained on the model. Professor Beggs also gave a diagrammatic demonstration of the use of models in the determination of thrust due to temperature.

Sanitary Engineering Division

Except for the time given to a short business session, the Sanitary Engineering Division devoted a whole day to the water-supply system of the city of Washington. In the morning J. E. Curtis, superintendent, Washington aqueduct and filtration plant, gave a historical sketch of the city's water-supply system and described in detail the recent additions, particularly the work of enlarging the aqueduct. He was followed by Philip O. Macqueen, superintendent of the Dalecarlia filtration plant, who described the purification facilities of the water-supply system. Discussion, which was led by Major B. B. Somervell, centered chiefly upon the details of the filtration plant. The afternoon was devoted to a trip of inspection of the new water-purification plant.

City Planning Division

Taking as a lead the fact that the city of Washington is the foremost example of the use of the round point in city planning, the City Planning Division devoted its session to that and allied subjects. The following papers were presented and discussed: The Round Point in the Design of Washington, by Charles W. Eliot, Washington, D. C.; Underground Utilities, Mains, Wires and Subways, by J. B. Gordon of Washington; The Architectural Development, by Albert L. Harris, also of Washington; and The City Planners' Summation, by George B. Ford, of New York. A fifth paper for the symposium was prepared by the late Charles W. Leavitt, landscape engineer, New York, shortly before his death. An interesting point in Mr. Eliot's paper was a description of the way in which outlying streets in Washington, not included in the original plan, are developed to conform with it.

Surveying and Mapping Division

Presentation and discussion of four committee reports occupied the whole time of the morning session of the Surveying and Mapping Division. The reports were those of the committee on boundary surveys, C. T. Johnston, chairman; topographic surveys, W. N. Brown, chairman; location and construction surveys, W. C. Taylor, chairman; and control surveys, C. V. Hodgson, chairman. Progress on the preparation of manuals was reported.

Many of those who spoke in discussion of the reports expressed the belief that the division should concentrate upon the problems of men in private practice rather than upon those of the government bureaus, all agreeing the government survey work was well in advance of that done by outside firms.

At the afternoon session the division considered two papers, one on the Surveying and Mapping Activities of the Federal Government, by T. W. Norcross, chief engineer of the U. S. Forest Service; and one entitled Good Maps Are a Sound Investment, by L. R. Lohr, editor, *The Military Engineer*, Washington. Colonel Norcross used the work of the Federal Board of Surveys and Maps as an outline about which to construct a description of the federal survey and mapping work. This board was appointed in 1919 to co-ordinate the activities of all federal mapping agencies. Captain Lohr described the many ways in which maps have been used to cut planning costs.

An interesting feature of the Surveying and Mapping Division meeting was an exhibit of distinctive instruments used in government survey work.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Radial or Parallel Slices in Analyzing Curved Dams?

Sir—In your March 15 issue F. W. Hanna states that the Lancha Plana gravity dam (arched in plan) was calculated for 25 per cent uplift at the heel and zero at the toe when a vertical slice with parallel planes is considered, but only 10 per cent uplift when a radial slice is considered. In *Proceedings* of the American Society of Civil Engineers, August, 1927, I called attention to the fact that in an arched gravity dam radial slices must be used. When the radius increases, these radial slices become more and more nearly parallel and finally become parallel when the dam is straight. In the paper referred to I showed that to compute an arched gravity dam as though it were a straight dam involves an error on the side of danger. In the discussion that followed, Mr. Hanna took exception to the radial slice theory and contended it was incorrect and could not yield correct results (*Proceedings,* January, 1928). Permit me to point out that even if the two methods of calculation were equally probable as far as their correctness goes, which they are not, an engineer designing a great dam should choose the one that is the safest. Mr. Hanna brought no defense of his contention that a slice with parallel sides should be used in an arched gravity dam and none can be brought. In the case of the Lancha Plana dam, the result of calculating for radial slices is that the dam is good for 10 per cent uplift and not for 25 per cent, which Mr. Hanna evidently thought he had designed it for.

That some arch action may exist and probably will exist must not be confused with the question of what the cantilever stresses amount to. A separate investigation must be made to show that arch action must exist and what it amounts to.

The failure of the St. Francis dam, which was a so-called arched gravity dam, will probably call a halt to the practice of skinning the gravity section down and then hoping that the arch action will take care of what the gravity dam cannot withstand. The Mulholland dam, a structure similar to the St. Francis dam and located above Hollywood, Calif., has several fairly large shrinkage cracks and it is generally problematical whether or not arch action can act before the uplift can make itself felt.

Los Angeles, Calif., April 5, 1928. B. F. JAKOBSEN, Consulting Engineer.

[Mr. Hanna's reply to the preceding comment follows.—EDITOR.]

Sir—Mr. Jakobsen refers to the writer's article of March 15 on "Designing a High Storage Dam for the Mokelumne Project." In the writer's discussion of Mr. Jakobsen's article in *Proceedings*, A.S.C.E., August, 1927, attention was called to the fact that the radial-plane theory of analysis of stresses in arched gravity dams is objectionable for several important reasons, all of which Mr. Jakobsen has ignored in his letter. It was pointed out (*a*) that a vertical slice of an arched gravity dam bounded by radial planes cannot be logically conceived as an independent unit of stability; (*b*) that the radial-plane method of analysis does not include the weight of all of the material of the dam; (*c*) that, if stresses in an arched gravity dam are calculated on parallel-sided sections of reasonable width, the results do not differ materially from those obtained from calculating them on the basis of the usual methods for straight gravity dams; and (*d*) that the radial-plane theory neglects the effect of arch action. The reasons for these contentions are fully set forth in the writer's discussion of Mr. Jakobsen's paper and need not be repeated here.

It appears evident to the writer that no logical argument can be made for using, in stress computations, a radial-sided vertical slice of an arched gravity dam 1 ft. wide, for, in a nutshell, such a slice cannot fail by shearing out of the dam or by sliding on its base or by overturning without involving adjacent sections of the dam. It is to these inconsistencies that the writer objects. He is not an advocate of the arched gravity type of dam except where canyon shape or foundation conditions make it desirable. The writer in no way confuses the questions of arch and cantilever action; nor does he believe in designing an arched gravity dam to rely on arch action for its safety. The Lancha Plana dam is not so designed and has whatever arch action may develop as a surplus factor of safety.

Mr. Jakobsen says: "In the case of Lancha Plana dam the result is that the dam is good for 10 per cent uplift and not for 25 per cent, which Mr. Hanna evidently thought he had designed it for." The writer is fully aware that the uplift provided for in this dam is about 10 per cent on the radial-plane theory and about 25 per cent on the parallel-plane theory of figuring, and knows, moreover, that the dam is safe against failure under either theory. The Lancha Plana dam is being founded on an unusually watertight rock and has a very complete drainage system. It is being built in alternate sections, and the contraction joints between these sections and the entire foundation, including the abutments, are being thoroughly grouted. The horizontal construction joints are being thoroughly mortared together to prevent percolation and uplift in the body of the dam. Under these conditions there is no probability of there being as much as 10 per cent uplift either within or on the base of this dam.

In the concluding paragraph of Mr. Jakobsen's letter he calls attention to the failure of the St. Francis dam, indicating that its failure was due to the skinning down of the gravity sections in arched gravity dams. If Mr. Jakobsen has visited the site of the St. Francis dam or has read the report of the engineers appointed by the Governor of California to report on the causes of the failure of this dam, he should know that neither the section nor the arching of the plan of the dam had anything to do with the failure of the structure. This was due to poor foundation, the usual source of failure of straight as well as arched gravity dams.

Oakland, Calif., April 17, 1928. F. W. HANNA.

Constant-Angle Arch Dams With Straight Gravity Abutments

Sir—In the last few years a number of big arch dams with straight gravity abutments have been constructed or designed, most of them of the variable radius type. It may be sufficient to refer to the dams constructed by the Feather River Power Company, described recently in *Western Construction News.* Typical also are the arch designs for the Exchequer dam published in the *Proceedings* of the A.S.C.E. for 1927, p. 2358, and the storage dam for the Mokelumne project published in *Engineering News-Record*, March 15, 1928, p. 444. These dams are usually referred to as "constant-angle arch dams," but the constant-angle arch idea seems to have been forgotten and only the drawback of the constant-angle arch system—namely, the variable radius—remains.

To have a variable radius is in itself a drawback, since it leads to weaker cantilevers. It pushes the center of gravity for the highest cantilevers downstream and hence reduces the ability of the cantilevers to take loads; and for dams with a high ratio between the span and the height of the dam the cantilevers always have to take a very important part of the load, and the most dangerous stresses in such dams usually are the vertical stresses in the cantilevers.

The idea of the constant-angle arch dam is based on the fact that the most economical arch is one with a central angle of about 120 deg., if the cylinder formula is correct. Since the system used at present does not make the cylinder formula valid, the theoretical best angle should actually be 150 to 160 deg., but it is difficult to use such great angles because of the foundation at the abutments. If, then, the span of the arch is different for different elevations—less at the bottom than at the crest—a use of a variable radius is logical in order to keep the central angle substantially constant, at least as long as such a dam does not give

stresses in the cantilevers more dangerous than those occurring in the arches.

However, if the arch dam has straight gravity abutments, how is it then with the span? For the height of these abutments the arch, of course, has a constant span. The reasonable thing, then, should be to use a constant radius too, at least for the height in question. For the dams mentioned, that is for the upper one-half to two-thirds of the total height of the dam. At first, with the radius for this part of the dam constant, the dam is a true "constant-angle arch dam" and at the same time without the drawback of the variable radius. Whether the radius for the lower part of the dam is variable or not is actually of little importance, since the cantilevers here usually take the major part of the load, because these dams with gravity abutments generally have a high ratio between span and height.

For instance, for the last-mentioned dam (arch design for Mokelumne project) the central angle at the lower part of the gravity abutments seems to be about 125 deg., according to the drawing. At the top, where the span is just the same, the radius is increased and accordingly the central angle is decreased from 125 to 90 deg. This means that the upper arches in an artificial way are made less economical than necessary by using the variable radius and not the constant-angle principle, the latter being the same as using constant radius.

FREDRIK VOGT.

Boulder, Colo., April 3, 1928.

Soil Study, Frost Action and Colloids

Sir—In his paper "Road Builders Require New Soil Studies," in your issue of April 19, V. R. Burton expresses the opinion that most of the present studies of the relation of soils to pavement structures appear aimless, so far as any practical application of results are concerned. That is true for endeavors in the field of every applied science before the first positive results are obtained. However, the work of the Bureau of Public Roads has advanced to such a point that the publication of the first tangible results is a matter of a few months. These results are very encouraging, and it is believed that their publication will remove the doubts that still exist concerning the practical value of laboratory tests.

Concerning the effect of frost on soils, no soil tests—neither physical nor chemical tests—have yet been devised which give us sufficient information concerning this important point. That, at least, was the situation disclosed at the meeting of the Highway Research Board of the National Research Council last December. In dealing with this problem, both Michigan and Washington depend on field studies and freezing tests. Hence the distinguishing difference between the Michigan methods and the others lies essentially in their attitude toward the colloid content of the soil in its bearing on properties other than behavior at low temperatures. However, the colloidal and the physical aspects of the soils merely represent two different sides of precisely the same thing, as do, for instance, the colloid character of portland cement on the one hand and the elastic properties, shrinkage, etc., of concrete on the other hand. Every difference in the colloid character is reflected by a corresponding difference in the physical properties.

The statement that "any theory of soil mechanics that does not take into account the existence of the colloid fraction is fundamentally wrong" is equivalent to rejecting the theory of reinforced concrete on the ground that it disregards the calcium and silica content of the cement. The very instant we introduce into our theory the compressive strength, we automatically introduce the calcium and silica content of the cement, and the only question is whether it is more economical to measure the strength directly or to deduce it from the results of a chemical analysis of the cement. Or, if the physical soil tests indicate appreciable cohesion and shrinkage, we automatically know that the soil contains an appreciable percentage of "active colloids."

In spite of such minor disagreements, there are few things more apt to stimulate the advancement of an applied science effectively than the simultaneous attack of identical problems from different sides. Every move made on one side is apt to fertilize and to check the endeavors on the other. For this reason the writer gladly welcomes the Michigan investigations and has been following them with keenest interest.

The Ann Arbor findings concerning the shrinkage of clays saturated with different liquids were made contemporaneously with the important findings of Professor Goldschmidt in Oslo concerning the polarized state of water in the voids of Norwegian clays, and with investigations at the Massachusetts Institute of Technology concerning some new aspects of the cohesion of clays. Thus every investigator contributes his share toward the difficult task of establishing the truth.

CHARLES TERZAGHI,
Research Consultant to the
Bureau of Public Roads.

Cambridge, Mass.,
April 19, 1928.

Eccentric Bending in Columns

Sir—Recently in a discussion of bending moments in columns I found a remarkable difference of opinion and of practice in figuring bending moments in columns. It is a matter that appears to me to be of much economic importance and that affects the structural steel industry particularly, especially in relation to competition with reinforced concrete.

Essentially the question is what bending moment in a column due to eccentric load should be used in designing a column. For years I have been using the actual bending moment in the column and I suppose other engineers have been doing the same thing; but it has just occurred to me that possibly many engineers have been using the bending moment in the bracket or eccentric distance which is recommended in such handbooks as the Carnegie Pocket Companion, Kidder and Nolan, and Hool and Johnson's Handbook of Building Construction. The method illustrated in these books is wrong; it is too conservative at least. Even assuming computations to be made as recommended in these books for the purpose of being conservative, it is still wrong because that is an indefinite and inconsistent way of introducing a factor of safety. It is very seriously wrong because even if it were true that the bending moments in a continuous column were equal to the product of the eccentric load P multiplied by the eccentric distance x—that is, the same as in the bracket itself, the maximum moment at the critical point in the column would be much less than Px when the load P is at or near a support. The moment Px exists in the column only at the top of a non-continuous column which is merely supported at the bottom.

The case I had under discussion is a fifteen-story building with eccentric load on the outside of columns at all floors. With all floors equally loaded, the moment at the critical point of the column is zero, whereas my opponents contended for figuring the moment as Px in all stories. This would have amounted to adding the necessary metal to resist approximately a 150,000 in.-lb. moment all the way up the building, whereas the moment at the center of unsupported length is practically zero and the moment at the floors could not much exceed $\frac{1}{2}Px$. In addition to this, if I had been designing a concrete building instead of a steel building, I would have figured the reverse bending moment (the negative moment at ends of slabs) due to the concrete slabs coming into the eccentric spandrel beams, and this moment would have practically neutralized the eccentric moment. In the case in question I did take this reverse moment into account, though, so far as I know, there is no precedent for it and no code that would permit it.

About three years ago at a meeting of the American Institute of Steel Construction I suggested the desirability of tests on large colunm sections with a definite bending moment due to something other than the application of the direct load off center. At that time I stated that I believed that results would indicate stresses lower than computed stresses. In this connection it is apparent that if the maximum moments, which are nearly always at supports, are assumed to be at the center or critical point, my contention ought to be correct. If, instead of figuring the real moment, a moment nearly twice as large is used in computations, the result must be waste of material unless our theory of combined stresses is entirely wrong.

W. C. SPIKER,
Consulting Engineer.

Atlanta, Ga., Feb. 15, 1928.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

San Francisco to Buy Spring Valley Water Company

Bond issues totaling $65,000,000 to buy out the Spring Valley Water Company and finish the Hetch Hetchy aqueduct were authorized by the voters of San Francisco on May 1. (See *Engineering News-Record*, March 8 and April 19, 1928, pp. 417 and 614.) Telegraphic reports give the vote on the $41,000,000 Spring Valley purchase as 80,000 for to 21,000 against and on Hetch Hetchy bonds as 93,000 to 11,500, in both cases far above the required two-thirds majority. Four earlier votes on the Spring Valley purchase all gave an actual but not a legal majority.

The Hetch Hetchy bonds will complete the project in so far as present needs are required; that is, they will provide for delivery of mountain water to the Crystal Springs reservoir of the Spring Valley Company on the San Francisco peninsula. On the conduits to be built in the form of a series of steel pipes across the valley, only the first 60-in. unit would be laid with funds provided for in the present bond issues.

The feature of uncompleted work on the Hetch Hetchy project that would require the longest time to finish is the Coast Range tunnel on which shafts have been sunk, roads built and camps constructed. This work is in shape to be carried through at high speed as soon as the bonds authorized at this election are marketed.

Long Bridge Planned Over Cape Fear River in North Carolina

Bids have been received on the Cape Fear River Bridge at Wilmington, N. C., by the state highway commission. This is claimed to be the most expensive bridge yet to be built in the state, the legislature having authorized a special bond issue of $1,250,000 for its construction. The project will include two bridges, one across the Northeast Cape Fear River and another across the Cape Fear River, with a 24-ft. causeway connecting the two.

Engineering Subjects at Carnegie Tech Summer Session

Engineering subjects are to receive special attention in the coming summer session of Carnegie Institute of Technology, in Pittsburgh. Courses of six and eight weeks will be given, starting June 11. Subjects of interest to civil engineers will be in mechanics, surveying, mathematics, engineering drawing and architecture. The courses are for those desiring a review as well as for the undergraduate.

American Welding Society Holds Annual Meeting

Planning Series of Tests on Welded Structural Members to Clarify Design

THE Engineering Societies Building in New York City was the scene of the annual meeting of the American Welding Society, April 25 to 27. New officers for the coming year were elected as follows: President, F. T. Llewellyn; senior vice-president, A. E. Gaynor; divisional vice-presidents, Ernest Lunn (Middle Western division), J. W. Meadowcroft (Middle Eastern division), H. P. Peabody (New York and New England division); directors at large, A. M. Candy, J. H. Deppeler, E. H. Ewertz and S. W. Miller.

The society has procured funds which will make possible a large number of tests on welded joints in structural steel members. Procedure specifications are in preparation covering general information upon the tests, qualifications of welders, standard test specimens, inspection and supervision, design of specimens and the actual testing. Copies of the procedure specifications, as modified at the meeting, will be available in about a month. It is expected that this series of tests of welding done in various parts of the country by many different welders will provide ample data upon which to base accurate design in future welded structures.

During the meeting papers were presented on "Welding Corrosion-Resisting Steel Alloys," by W. B. Miller, of the Union Carbide & Carbon Research Laboratories; "Building Up Rail Ends by the Electric Arc Process," by H. E. McKee, of the Electric Rail Weld Service Corporation; and "Welding the Ford Car," by M. L. Eckman, of the Ford Motor Company.

Purchase of Airport Sites Urged

Prompt acquisition of ample areas for all possible purposes in connection with air transportation within a 50-mile radius of New York City will be urged by the final report on transit and transportation soon to be published by the Regional Plan of New York and Its Environs. The report also stresses the importance of adequate rapid transit between airport sites and the main business and residential parts of the city as well as other cities in the metropolitan area. It is brought out that the use of aircraft will undoubtedly increase rapidly, that airport sites can be acquired now much more cheaply than later and that any land not put to immediate use will add needed area to the parks and recreation grounds.

Lehigh Valley Control Passes to Pennsylvania Railroad

What amounts to almost if not quite actual control of the Lehigh Valley Railroad passed to the Pennsylvania Railroad last week when the Delaware & Hudson Company sold to the Pennsylvania its stock in the Lehigh Valley and Wabash railroads. An announcement of the sale was made on April 27 by L. F. Loree, president of the Delaware & Hudson Company.

The event is significant in its relation to railroad consolidation as it appears to mark the abandonment of Mr. Loree's plans for a fifth trunk railway in the eastern part of the country, plans which have been developing during the past few years and which have met with numerous difficulties, chiefly the refusal of the Interstate Commerce Commission to permit construction of a new railway from Pittsburgh to Easton, Penn., or to approve Mr. Loree's plans for making both the Delaware & Hudson and the Buffalo, Rochester & Pittsburgh Railroad part of one system by using trackage rights of the intervening tracks of the Pennsylvania.

Control of the Lehigh Valley Railroad is now about equally divided between the Pennsylvania and the New York Central. At the recent annual meeting of the Lehigh Valley stockholders it was difficult to tell whether the New York Central or the D. & H. actually had control, due to the number of proxies which were disqualified.

The price paid for the stock was not revealed, but it has been estimated to be about $63,000,000.

Power Projects in West Virginia, Washington and California

Having completed the work called for in its preliminary permit, the Gauley Power Company, Charleston, W. Va., has applied to the Federal Power Commission for a license covering the project it has been examining on the Gauley River. The company plans to construct a concrete 125-ft. dam at a point 21 miles from the mouth of the river, where, it is estimated, 54,500 hp. of primary power will be made available. It is proposed to install three 20,000-hp. generators. This is one of the few applications received from West Virginia since the enactment of the water-power law, due to the unsatisfactory character of the state law.

The Washington Electric Company, of Seattle, has applied for a preliminary permit covering a project on the Sultan River near Sultan, Wash., where it proposes to build a 310-ft. dam creating a reservoir of 230,000 acre-ft. capacity.

Washington Notes

Flood-Control Bill Still in Conference—Senate Completes Highway Legislation Program

By Paul Wooton
Washington Correspondent

DIFFERENCES between the flood-control bill passed in the Senate and that approved by the House were on the point of being harmonized as this issue goes to press. An effort failed to secure the concurrence of the Senate in the House amendments so as to make a conference unnecessary. Most of the legislators from the Mississippi Valley were of the impression that the President would sign the House bill. They fear that the conferees may add features of the Senate bill which will make it less acceptable to the President. On the other hand, the President is understood to have insisted that there be a conference, particularly for the purpose of modifying the compensation section. The President does not want the legislation to go farther than does the Constitution in providing that just compensation be made for private property taken for public use.

The President is insisting that the conference bill provide for a planning board of three and that there be no substitution of the five-member board provided in the Senate bill. The Senate conferees, however, are insisting that the board have authority to make decisions. The House bill requires Presidential approval before decisions can be put into effect. As the Chief of Engineers passes on engineering matters submitted to the President, such a provision, many believe, would defeat the purpose of the board.

Contract or Force-Account Work

A determined effort is being made to get the Campbell bill before the House at this time, when the Corps of Engineers is in greater disfavor than perhaps at any previous time. The object of the bill is to require government agencies to exhaust every effort to secure competitive outside bids before undertaking public construction on their own account. Chief opposition to the bill comes from the Corps of Engineers. Heretofore members of Congress from the Mississippi Valley have been relied upon to oppose the measure. The Representative who led the fight against the measure at the last session declares that he will play no such rôle should the bill come up again, and he goes so far as to say that perhaps the measure is justified if the engineers are as unethical in their dealings with private contractors as they have been in their relationships with flood-control legislation. At the offices of the Associated General Contractors it is stated that the recent order with regard to competitive bidding should not be regarded as making the Campbell bill unnecessary. A law on the statute books, it is pointed out, cannot be repealed without all concerned having an opportunity to present their case. An order such as that recently issued can be repealed whenever the Chief of Engineers desires. An extract from that order reads:

"It is the general policy of this office to have practically all work open to competitive bidding (if, in the opinion of the Chief of Engineers, contractors will bid on the work), provided that the nature of the work and the time available for execution permit. Sufficient government plant will be kept in operation to furnish an accurate index of cost on various types of work, so that the justness of contract prices can be exactly determined, to have at hand an organization for meeting emergencies and to have plant available for the purpose of developing and increasing the efficiency of engineering methods."

Federal Highway Appropriations

With the passage of the bill authorizing the appropriation of expenditures at the rate of $3,500,000 annually on roads in public lands, the Senate has disposed of all of the general highway legislation brought forward at this session. All of the bills are on the House calendar, but thus far it has been impossible to secure a rule for their consideration. Unless a rule is forthcoming promptly it is the plan of those in charge of this legislation to bring up the bills under a suspension of the rules. This will require a two-thirds vote, but they feel confident that the bills can be passed.

Favoring American Materials

Differences between contractors and manufacturers over the best method of favoring American materials in federal construction work will probably be settled outside of Congress, according to a letter recently issued from the Interdepartmental Board of Contracts and Adjustments. This letter was sent to Representative Wood, of Indiana, who has a bill on the calendar seeking to give precedence to American materials. The Associated General Contractors, however, declared themselves in opposition to Mr. Wood's bill, not because they were out of sympathy with using home products but rather due to their fear that the bill was too general and would impose additional burdens on the contractors.

The letter from the Interdepartmental Board calls attention to the fact that the board itself adopted resolutions on April 20 which give priority to American materials. It is believed that the objections raised by the Associated General Contractors to the Wood bill are met by these resolutions. The particular objection of the A.G.C. to the Wood measure is that no definition is given whether materials fabricated in this country are to be considered as foreign or domestic and that the contractors would be seriously hampered therefore in specifying on this type of product. The resolution adopted by the Interdepartmental Board meets this objection, domestic articles or materials being defined as meaning articles or materials manufactured or assembled in the United States or its possessions. The text of the resolution is as follows:

"Preference for domestic articles or materials will be given, conditions of quality and price, including duty, being equal. Unless otherwise stated in the bid it will be understood that domestic articles or materials only will be used and the use of foreign articles or materials will not be permitted unless they are of better quality, or, being of equal quality, will be furnished at a lower cost to the government, or where domestic articles are not available. The term domestic articles or materials in this connection means articles or materials manufactured or assembled in the United States or its possessions.

"This board also recommends that the departments and establishments be instructed that hereafter when preparing specifications for the construction or repair of public buildings or works, the foregoing paragraph will be inserted in the specifications or other appropriate papers forming a part of the contract and that, when practicable, it also be used in the procurement of supplies."

Cleveland Again Votes to Retain City-Manager Plan

Amendments to the charter of Cleveland, Ohio, providing for the abandonment of the council-manager plan, with election of the council by proportional representation, and a return to a mayor and council, the latter elected by wards, were defeated on April 24 by a vote of 41,035 for the amendment to 43,798 against, or an adverse majority of 2,763. Last year the same general proposal was defeated by a majority of about 6,400 in a total vote of 154,000 cast in the city.

Mystery Water Meter Bill Before Philadelphia Council

A bill for the installation, by a contractor, of meters on all unmetered water services in Philadelphia, either identical with or similar to one that failed of passage a few years ago, has been introduced in the city council. The bill authorizes the director of public service (Alexander Murdoch) to advertise for bids for meters to be installed at the rate of 10,000 a month. The work would be done at the cost of property owners, who would pay for it in twenty quarter-yearly installments. The city would collect the payments and turn them over to the contractor. It is said that about 400,000 meters would be required. The bill provides that three months after the passage of the ordinance no water could be sold except by meter measurement. No disclosure has been made either as to who has 400,000 meters in stock or who is responsible for the bill, which was referred on April 26 to a committee for a report after a public hearing has been held.

Building Officials' Conference Meets in Detroit

The fourteenth annual meeting of Building Officials' Conference was held at the Hotel Statler, Detroit, April 24 to 27.

Among the topics discussed were structural gypsum, steel joints, metal lath as fire protection, the standard fire test, the severity of building fires, brick masonry, the practical application of water-cement ratio in concrete construction, the inspection of concrete, inspection and certification of concrete blocks, sand, lime and brick, and departmental administration.

The trend, in statutory regulation of building construction, toward broader requirements looking to objects to be attended to rather than specific methods of accomplishment was evident in the papers and discussion. The compulsory removal of old abandoned buildings on the ground of being eyesores, subject to wanton destruction by trespassers and likely to become unsafe, was debated and strongly advocated. A resolution was adopted urging the provision in building codes of only one set of working stresses for structural materials—namely, that for the poorest permissible grade—unless such materials bear authentic brand marks or other evidence of better grade and therefore entitled to the use of higher working stresses.

The last day of the convention was given over to visits to the building department laboratory, the Gabriel Steel Company's plant and other points of interest.

Officers for the coming year were elected as follows: President, Robert Knight of Chicago; vice-president, John Fowler, Jacksonville; secretary-treasurer, John W. Oehmann, Washington.

Wanaque Aqueduct and Aerator Fate Uncertain

Changes in plans for the Wanaque aerators and aqueduct of the North Jersey Water Supply District recommended by George W. Fuller, consulting engineer, New York City, as outlined in *Engineering News-Record*, April 26, 1928, p. 678, were approved on April 26 by two of the four members of the North Jersey District Water Supply Commission, one member being absent and one not voting. Mr. Fuller was engaged by three of the eight communities forming the district —Paterson, Passaic and Clifton. A fourth city, Kearny, is said to favor the changes. Newark, represented on the commission by its mayor, the absent member at the time of the vote, is said to be against the recommendations. The proposed changes cannot be made without the consent of all eight of the contracting municipalities. It is reported that the district commission voted on the recommendations without first getting an opinion regarding them from its chief and consulting engineers, Arthur H. Pratt and Morris Sherrerd.

Tunnel Cave-Ins Delay Trains

The Palmyra tunnel of the Louisville & Nashville Railroad, 12 miles west of Clarksville, Tenn., was blocked by two cave-ins on April 21. Heavy rains during the preceding week are believed to have caused the trouble. Work has been in progress for some time in enlarging the tunnel. While the tunnel was blocked passenger traffic was detoured, causing a delay of about three hours in schedule.

Pontiac to Vote on Improvements

The electors of the city of Pontiac, Mich., will vote at a special election on May 10 on a bond issue of $2,000,000 to provide money for additional sewers, pavements, water-works extensions, an addition to the city hospital and a municipal airport. The major items to be provided for if the issue passes are: Sanitary sewers, $330,000; storm-water drains, $360,000; pavements, $270,000; water system extensions, $390,000; municipal buildings, $300,000.

Massachusetts Dam Opposed

The plans of Springfield, Mass., for enlarging its water supply by the construction of an earth dam to impound 22,500,000,000 gal. are being strongly opposed by the citizens of Westfield, which is 7 miles below the site of the proposed dam. Governor Fuller, of Massachusetts, has been asked to veto a bill now before him giving Springfield authority to finance the project by a $4,500,000 bond issue.

Westfield contends that the presence of the dam and reservoir will act as a constant threat, retarding the growth and industrial life of the city. It is claimed that the amount of water impounded will be unnecessarily large in order to provide for power development.

Governor Fuller will call for expert engineering advice and opinions upon the safety of the project before signing the bill.

City Engineer Advises Large Bond Issue by Salt Lake City

A $6,800,000 bond issue for public improvements at Salt Lake City is recommended by Harry C. Jessen, city engineer, in his annual report, just submitted to the city commission. The largest project is a $3,500,000 dam and reservoir in Big Cottonwood Canyon. Other water-works extensions advised are reconstruction of the Sunnyside reservoir, $65,000; two 10-m.g.d. reservoirs, $135,000; water mains, $600,000. An outlay of $1,000,000 to meet the city's share of paving, gutter and curb construction is proposed, $350,000 for storm-water sewers and also $1,000,000 toward a civic center. John F. Bowman is mayor and city commissioner in charge of water-works, and P. J. Moran is city commissioner in charge of streets and public improvements.

Great Lakes Improvements Favored by Army Engineers

The Chief of Engineers has forwarded to the Secretary of War, for transmission to Congress, a report on the preliminary examination and survey of the Great Lakes. This recommends certain modifications in the existing project for Great Lakes connecting channels. It affects the deepening and widening of a number of channels and the construction of compensating works. The total cost of these improvements is estimated at $24,000,000, with $165,000 annually for maintenance. The report finds the cost of compensating works amply justified.

When the question of diversion at Chicago is finally settled, the Chicago Drainage District can be called upon to pay its share, if any, of the cost of compensating works, according to the report. Also, it states that the findings do not authorize any diversion from Lake Michigan, nor do they affect in any way the status of that question.

The army engineers recommend that the channels of the St. Clair Canal be deepened to 24 ft. in soft bottom, generally 25 ft. in hard bottom, 25 ft. through the shoal at the foot of Lake Huron (800 ft. in width), 25 ft. in the Fighting Island Channels and through the Livingston Channel, 26 ft. in Round Island Middle Ground and Round Island Shoals Nos. 1 and 2, and 27 ft. in West Neebish Rock Cut; that the channel through the Southeast Bend, St. Clair River, be widened to 600 ft.; and that compensation works be constructed in the St. Clair and Niagara rivers.

Federal Court Upholds St. Paul's Condemnation of Property

The United States court has upheld the condemnation of the Third St. property, which represents one of St. Paul's large city planning projects. It includes all land and buildings lying between Third St. and the river bluff for four blocks and a piece of land one-half block wide for two blocks.

The Schlitz Brewing Company, of Milwaukee, owning 25 ft. frontage, asked for an injunction in the federal court on the ground that the condemnation proceedings were not legal. St. Paul's city charter provides that the commissioner of finance shall determine the value of property taken under condemnation proceedings and that the city council after reviewing this determination shall approve or disapprove this value. The values fixed are later confirmed by the court. Judge Cant held that under the charter provision the court reserves a real control whereby it can effectively prevent the city taking property until the court is satisfied a fair value is determined. He denied the injunction.

This is a decided victory for the city and permits it to go ahead with tearing down the buildings. The intention is to construct a 72-ft. marginal street with two 20-ft. sidewalks, and to devote the remainder of the site to parking area.

Random Lines

Quite a Deep Crossing

The *Evening Post*, New York, recently published the following interesting data concerning the Mersey Tunnel:

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London, April 21.—England's nearest equivalent to the Hudson vehicular tunnel—namely, the $25,000,000 vehicular tunnel under the Mersey, connecting Liverpool with Birkenhead—has just been finished, so far as excavation is concerned.

The borings from the two opposite sides met 1,700 ft. below the river bed and the last remaining partition of the rock was broken through by Sir Archibald Salvidge, the chairman of the Mersey Tunnel Committee.

Is That So!

The following is extracted from a letter to the New York *Times:*

Apropos of the *Times* editorial "Flood Control," should we not insist as a prelude to any expenditure of national funds in the Mississippi Valley that the 8,500 cu.ft. per second of water from the Great Lakes which the Secretary of War permits the city of Chicago to divert into the Mississippi River day in and day out shall be cut off?

The recent report of Charles E. Hughes as to this diversion showed that by this withdrawal Lake Michigan's level had been pulled down by 6 in. and Lake Huron's level by 4 in. As Lake Michigan's area is 20,000 square miles, and Lake Huron's 21,000 square miles, the body of water which Chicago sends annually into the Mississippi by way of the Illinois River would cover 17,000 square miles with water 1 ft. in depth. The area of the Mississippi River's channel below the mouth of the Illinois River is approximately 2,300 square miles, so that this Great Lakes water raises for long stretches the level of the Mississippi from 5 to 7 ft.

Probably King George secreted the water somewhere in Illinois and dumped it all into the Mississippi at the time of the peak of the flood.

A Simple Problem in Hydraulics

Flushing, too, has its traffic problem, to which Mr. Racusin might turn his attention one of these days. It seems that Northern Boulevard, in that settlement, is overcrowded and that Something has got to be done about it. To this end, a petition is being circulated by owners of homes in Flushing, and at least one of its sections is fascinating. Thus, according to the Flushing *Journal*, it goes:

(d)—Whenever the lift bridge is raised, traffic is naturally held up east and west of the bridge for blocks. The solution is to deepen the channel so that boats can pass below without lifting the bridge.

The submarine, apparently, is about to come into its peace-time own.

Or perhaps the home-owners are thinking of solving the bridge question by putting a dip in the river. If so, they should be careful to remember how dangerous it is to operate ships on steep grades.—*Edward Hope in the New York Herald Tribune.*

$14,700,000 in Public Works Probable in New Orleans

Bonds totaling $9,000,000, which, together with yearly revenue, will make $14,700,000 available for water, sewer and drainage extensions at New Orleans in the next three years, were authorized by an amendment to the Louisiana Constitution on April 17. The $14,700,000 will be divided as follows: Water-works, $2,300,300, of which $1,300,000 is to increase capacity of low-lift or sewer pumps and of water-purification plant from 40 to 112 m.g.d., and $1,000,000 for water main extensions; sewers to outlying territory, $2,800,000; water and sewer connections to property lines, $800,000; drainage, $8,300,000, of which $2,900,000 is for pumping extensions and $5,400,000 to enlarge or line main outfall canals; for changes in advance of street paving for sub-surface drainage and for plumbing inspection, $500,000.

At the same election, the Louisiana Constitution was amended so that hereafter water, sewer and drainage bonds may be issued when authorized locally, provided the issues are approved by three-fourths of the members of the sewerage and water board, two-thirds of the members of the city council, a majority in numbers and amount of property of the taxpayers of New Orleans and three-fourths of the members of the board of liquidation, city debt; and provided that the total outstanding bonds of the city shall never exceed 5 per cent of the assessed valuation of all the taxable property of the city.

Force Main Break Cuts Off Part of Detroit Water Supply

A break in a 48-in. high-service force main at Garland and Sterritt Aves., Detroit, Mich., on April 25 necessitated the shutdown of three 37-m.g.d. pumps, a brief suspension of work in many large industrial plants, lack of water in thousands of homes and interruption of foot and vehicular traffic in a large flooded area. The break occurred soon after 8 a.m. A partial supply through smaller mains was made available in about two hours and a full supply within a day or two.

Railway Improvements Planned at Toronto

The Canadian National Railways have been authorized by Parliament to spend an additional $3,500,000 on facilities at the new Toronto viaduct. It is proposed to construct an engine house at a cost of $2,000,000 for the exclusive use of the C.N.R. In addition, construction of an express house, with express facilities, offices and power house, are also intended. The viaduct and works will probably be completed in about two years. It has been estimated that the total contribution of the C.N.R. to the cost of the viaduct and incidental works will amount to $17,500,000.

Brief News

A NEW BRIDGE over the Ohio River at Louisville has been approved by the Secretary of War.

OWNERSHIP AND OPERATION of parks by Fulton County, Georgia, in which Atlanta is located, has been authorized by a large majority on a referendum vote.

CONSTRUCTION OF A TOLL BRIDGE over the St. Maurice River at Grandmere has been made possible by the recent vote of the Quebec government providing $400,000 for the project.

PLANS FOR A BRIDGE to be constructed over the Tennessee River near Perryville, Tenn., have been approved by the War Department following their submission by the Tennessee Department of Highways and Public Works.

THE DOULTON TUNNEL of the Montecito (Calif.), water supply has been holed through. It is 7 ft. wide, 9 ft. high and 11,400 ft. long. The cost of construction averaged $37 a linear foot.

GATES FOR LOCK NO. 1 of the new Welland Canal at St. Catherines, Ont., were tested for the first time on April 23. The gates weigh 450 tons each and are operated by electricity. Despite the effect of a high wind during the test, the power needed to operate the gates was far less than has been expected.

THE APPROVAL of the Ontario Legislature has been asked for the incorporation of a company to be known as the Kenora & Red Lake Railway Company to build 150 miles of railway connecting Kenora, Ont., with the Red Lake mining area. It is understood the new company will be a subsidiary of the Kenora Paper Mills, Ltd.

A PUBLIC IMPROVEMENT PROGRAM to cost about $8,000,000 has been mapped out for the spring and summer in Baltimore by Charles F. Goob, chief engineer of the city. It will include three bridges, street paving, extension of the water and conduit systems, sanitary and storm water sewer work and pier and wharf work.

PHILADELPHIA VOTERS approved on April 22 two bond issues aggregating $47,000,000, which makes certain several municipal improvements of importance. Among these are the underground concourse around the city hall, the beautification work on the eastern bank of the Schuylkill River under the agreement with the B. & O. Railroad, continuance of the work incident to reconstruction within the city of the Pennsylvania Railroad, work required by the electrification of the Chestnut Hill branch of the Reading Railroad and additional facilities for sewage disposal.

Personal Notes

EDWIN C. KELTON, Major, Corps of Engineers, has been transferred from the office of the Assistant Secretary of War to duty as district engineer at Memphis, Tenn.

W. D. A. ANDERSON, Lieutenant-Colonel, Corps of Engineers, has been transferred from Fort Humphreys, Virginia, to Mobile, Ala., for duty as district engineer, effective July 15.

EDWIN J. FORT has been made city manager of Englewood, N. J., under the new form of government recently established. Mr. Fort was formerly in the service of the city of New York in the borough of Brooklyn on the construction of sewers.

R. L. GRAY, J. M. DONAHUE and LEO P. RIEDER have filed articles of incorporation in Indiana as the R. L. Gray Company. The company will engage in contracting and engineering work, with headquarters in South Bend.

G. W. VOLCKMAN has accepted the appointment of chief engineer and representative in India and the Far East of Sir Alexander Gibb & Partners, consulting engineers, of Westminster, London, England. Mr. Volckman will make his headquarters in Bombay.

CLINTON A. PLUMLY has been appointed assistant to the chief engineer of the Maine Central Railroad, with office at Portland, Me. Mr. Plumly was graduated from the University of Maine in 1909, since which time he has been in the employ of the Maine Central, excepting the time he served in the army during the World War.

WILLIAM S. ORR, Niagara Falls, Ont., formerly with the Ontario Hydro Electric Power Commission on the Queenston-Chippawa development, has been appointed works commissioner of the city of Niagara Falls, Ont. His appointment combines the positions of city engineer and superintendent of outside construction.

DE WITT C. JONES, Major, Corps of Engineers, in charge of the Buffalo (N. Y.) engineering district, has been assigned to the Thirteenth Engineers, at Fort Humphreys, Virginia, and Major DAVID MCCOACH, JR., Corps of Engineers, at the Army War College, Washington Barracks, has been ordered to Detroit for river and harbor work.

HERMAN ROSENTRETER has been appointed by the City Commission of Newark, N. J., division engineer in charge of water to succeed the late John S. Ely. Mr. Rosentreter was formerly assistant engineer in charge of water and has been in the service of the city for 21 years.

HENRY B. VAN FLEET, formerly employed as designing engineer and construction superintendent by S. S. & G. H. Godley, architects, of Cincinnati, is now engaged in construction work on the Lookout Mountain Scenic Highway, which runs along the west brow of the mountain and connects Chattanooga, Gadsden and Birmingham. He has charge of construction on the 14-mile stretch extending northward from Mentone, Ala.

Engineering Societies

Calendar

Annual Meetings

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, May 7-10.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Annual Convention, El Paso, Tex., June 4, 5 and 6.

AMERICAN WATER WORKS ASSOCIATION, New York; Annual Convention, San Francisco, week of June 11.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION; Annual Meeting, University of North Carolina, June 25.

AMERICAN INSTITUTE OF QUANTITY SURVEYORS, Chicago; Annual Convention, New York, June 25-27.

THE COLORADO ENGINEERING COUNCIL, at its April 17 meeting, held in Denver, heard Prof. C. F. Poe, of the department of chemistry of the University of Colorado, on "What a Laboratory Examination of Water Indicates."

THE BALTIMORE ENGINEERS CLUB held a luncheon meeting on April 25 at which Howard W. Jackson, former Mayor of Baltimore, reviewed the accomplishments of his administration.

THE TAYLOR SOCIETY, in co-operation with the Society of Industrial Engineers and the Society of Time Study Engineers, will hold a meeting in Detroit on May 7 and 8. Meetings will be held mornings and afternoons of both days on the subject of "Time Study."

THE ENGINEERS' CLUB of Columbus, Ohio, at its annual election on April 20, elected Robert N. Waid president for the second term and C. D. McGuire secretary for the sixth term. Mr. Waid is examiner for the Ohio State Highway Department and Mr. McGuire is engineer for the Division of Water of Columbus.

THE MISSOURI VALLEY SECTION of the American Water Works Association is the new name of the former Iowa Section, this change having been made to represent more adequately the geographical territory included in the membership of this section. The annual meeting will be held at Kansas City, Mo., Oct. 2-5. The secretary is Jack J. Hinman, Jr., Iowa City, Iowa.

THE FLORIDA ENGINEERING SOCIETY held its twelfth annual convention in Jacksonville April 19-21. Emphasis was laid on the necessity of a state building code in the report of the committee on relations with architects, and the president was authorized to appoint a committee and ask the Florida Association of Architects and the Building Officials' Conference also to appoint committees to discuss the subject at a joint session.

THE SOUTHEASTERN WATER AND LIGHT ASSOCIATION held a three-day meeting in Atlanta, Ga., on April 17-19. Officers elected were: R. B. Sims, of Spartanburg, S. C., president; E. S. Tyner, Plant City, Fla.; W. G. Midleton, Yazoo, Miss.; H. A. Lily, Badin, N. C.; E. O. Sweet, Birmingham, Ala.; W. W. Hunter, Augusta, Ga.; J. B. Farmer, Murfreesboro, Tenn., and J. F. Pearsons, Orangeburg, S. C., vice-presidents, and S. W. Chapman, Camden, S. C., secretary.

THE ASSOCIATION OF CITY ENGINEERS OF NEW YORK STATE will hold its annual convention at the Hendrick Hudson Hotel, Troy, N. Y., on Wednesday, June 6. Prof. William W. Rousseau, of Rensselaer Polytechnic Institute, will present a paper on "The Engineer's Obligation to His Municipality in Matters Pertaining to Taxation and Assessments" during the morning session. In the afternoon S. M. Williams, manager of the engineering construction division of the A.G.C., will talk on "The Importance of Qualifying Bidders on Municipal Construction Work and the Advantages of the Use of the Standard Questionnaire."

Obituary

JOEL W. STEARNS, JR., vice-president of the General Construction Company, Denver, died on April 16, after an illness of several months. He was 30 years old.

ALMA KATZ, pioneer railroad builder, died in Salt Lake City, Utah, on April 15, aged 79 years. He was associated with Nelson Bennett in the construction of the Northern Pacific tunnel through the Cascade Mountains in Washington and the Twin Falls tunnel in Idaho.

JAMES M. DONGAN, of Portland, Ore., one of the oldest contractors in the Northwest, died recently from heart disease in his automobile while on the way to his office. He was 85 years old and had been one of the leading building contractors of Portland for 50 years.

Col. FRANK A. GIESTING, New York, who commanded the 302nd Engineers, 77th Division, in the World War, died on April 25 after an illness of a few weeks. He had been assistant to the chief executive officer of the Port of New York Authority for the last two years.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Exhibitors Apply for Space at Water Works Convention

The members of the Water Works Manufacturers Association will as usual maintain a large exhibition of water works materials and equipment at the convention of the American Water Works Association, June 11-15, 1928, at the Fairmont Hotel, San Francisco. The following companies have applied for exhibit space:

Leadite Co., Inc.
Automatic Cone Valve Co.
Simple Valve & Meter Co.
Pitometer Co.
Michigan Valve & Foundry Co.
Ross Valve Mfg. Co.
National Water Main Cleaning Co.
Giant Mfg. Co.
United States Cast Iron Pipe & Foundry Co.
Badger Meter Co.
Pittsburgh-Des Moines Steel Co.
Ford Meter Box Co.
Rensselaer Valve Co.
Gamon Meter Co.
Fairbanks Morse Co.
Eddy Valve Co.
Hersey Mfg. Co.
Art Concrete Works
R. D. Wood Co.
Engineering News-Record
Wailes-Dove-Hermiston
Builders Iron Foundry
Kennedy Valve Co.
Pittsburgh Equitable Meter Co.
American City
Burroughs Adding Machine Co.
Victaulic Company of America
Central Foundry Co.
Ed. E. Johnson, Inc.
American Brass Co.
American Cast Iron Pipe Co.
Columbian Iron Works
Chicago Bridge & Iron Works
Western Pipe & Steel Co.
Wallace & Tiernan Co.
La Motte Chemical Products Co.
Worthington Pump & Machinery Corp.
National Meter Co.
Mueller Co.
De Laval Steam Turbine Co.
Iowa Valve Co.
National Tube Co.
Western Concrete Pipe Co.
B. Nicoll & Co.
Jas. Jones Brass Co.
Neptune Meter Co.
Thomson Meter Co.
Federal Meter Co.
A. P. Smith Co.
Greenberg Sons Co.
Pacific States Cast Iron Pipe Co.
McWane Cast Iron Pipe Co.
Water Works Engineering
Shand & Jurs Co.
Public Works
Republic Brass Co.
Hydraulic Engineering Co.
Western Construction News
California Filter Co.
Gillette Publishing Co.
Forni Mfg. Co.
Linde Air Products Co.
Thomson Adriance Co.

Wrought Iron Manufacturers Form Association

Representatives of the leading manufacturers of wrought iron in various parts of the country formed on April 5 the Wrought Iron Research Association, the principal object of which is to gather and disseminate information about wrought iron. The headquarters of the association will be in Pittsburgh, Pa.

The origin of the association is based upon the belief that the wrought iron industry has long suffered for lack of knowledge on the part of the public about the characteristics of wrought iron, especially for those uses where a high degree of resistance to corrosion and vibration are necessary, and where a high welding quality is desired. The association believes that the public at large does not realize that it is possible today to purchase genuine wrought iron of exactly the same enduring quality as that which has been in use for over 150 years. It is the association's plan to inform the public of such facts as this, and to point out the applications where wrought iron can be used advantageously. Snowden Samuel of the American Swedo Iron Company, Philadelphia, is secretary-treasurer of the association.

Outdoor Equipment Show in Massachusetts

The construction equipment show held annually for the past few years at Cottage Farm Bridge near Boston is scheduled this year for May 9, 10 and 11. This show, held under the auspices of the Massachusetts Highway Association, has grown to be one of the largest outdoor exhibitions in the country. According to its own announcement, it has doubled its exhibits each year since its origin. Information pertaining to exhibits may be had from F. W. Mattheis, 285 Dorchester Avenue, Boston.

Business Notes

H. A. SCHAFFER, formerly conservation engineer, Portland Cement Association, has been appointed eastern sales manager of the Bates Valve Bag Corporation, Chicago. Before his connection with the Portland Cement Association, Mr. Schaffer was chief chemist of the Vulcanite Portland Cement Company, later chief chemist and manager of the Northampton Portland Cement Company, from 1914 to 1918 a member of the firm of Harrison and Schaffer, consulting engineers, and during the war, assistant to the director, building materials division of the War Industries Board.

THE MOORE SPEED CRANE will be built and controlled by the Manitowoc Engineering Works, Manitowoc, Wis., by an arrangement recently effected with the Moore Speed Crane Company, Chicago, which will continue as sales representative in Chicago for the Manitowoc Engineering Works. In New York City the sales agents will be Forsythe Bros., 30 Church Street.

J. M. CROM and A. C. LINBERG, who have been operating as partners representing the Cement Gun Co., Inc., in the middle west during the past five years, have severed their connections with this company and are continuing business under the name of Crom & Linberg, with offices at 549 West Washington Street, Chicago, Ill. E. A. EVANS of Providence, R. I., for the past eight years connected with the Cement Gun Co., Inc., is district manager and general superintendent, for Crom & Linberg.

COLUMBUS MCKINNON CHAIN COMPANY, Tonawanda, N. Y., has recently purchased the chain-block electric hoist and crane division of the Chisholm & Moore Mfg. Company, Cleveland. The sales offices and plant of the latter company will remain in Cleveland and will be operated as a division of the Columbus McKinnon Chain Company.

ERNEST L. BECKER, formerly with the Newport Rolling Mill Company, has accepted an executive position handling sales, research and advertising work for the H. W. Roos Co., Cincinnati, Ohio.

AMERICAN HOIST & DERRICK COMPANY, St. Paul, has appointed J. T. Seaver, Inc., Cleveland, Ohio, as its representative in the Cleveland district.

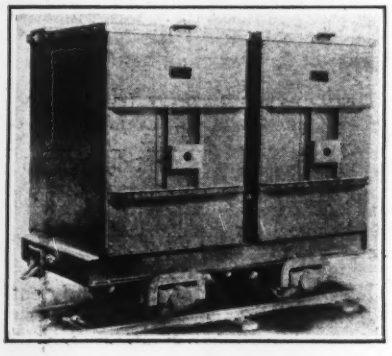
T. L. SMITH COMPANY, Milwaukee, announces the appointment of the R. P. Sweeny Company, Greenville, as its representative for the state of South Carolina, with the exception of Chester, York, Lancaster, Chesterfield and Marlboro counties. Announcement is also made of the appointment of Woodward-Wright Company, New Orleans, as distributor for Louisiana and southern Mississippi.

THE ROLLER BEARING COMPANY OF AMERICA, Newark, N. J., has recently purchased the plant of the Mercer Motor Car Company, Trenton, N. J., occupying 11½ acres and having 175,000 sq.ft. of floor space. The company will move its present equipment to its new plant, and states that with the purchase of new equipment it will be in a position to handle its increasing sales.

New Developments

New Batch Box Car Carries Two 48-Cu.Ft. Boxes

A new batch box car and batch boxes for road work have recently been announced by the Lakewood Engineering Company, Cleveland, Ohio. The car is designed to handle two 48-cu.ft. batch boxes. It has a frame of 6-in. ship

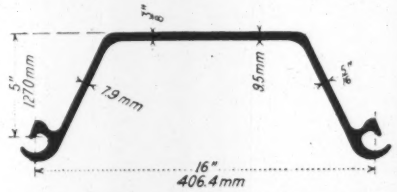


channels strongly braced and reinforced. The alloy steel axles have a journal 2½x6 in. and ride on either Lakewood cage roller bearings or Hyatt bearings. Complete spring draft rigging is standard equipment. The wheels are of cast steel 14 in. in diameter.

The batch box has adjustable trunnions, making it possible to alter the tripping axis of the box to allow for variations in sizes of batches. It is stated that the growing practice of weighing materials has made this feature of greater importance than ever before. Another feature is the use of a chain at the bottom of the cement compartment which helps to clean the cement as the car is dumped. Besides being made in a 48-cu.ft. size, these boxes are also available in 41- and 45-cu.ft. sizes.

New Sheet Piling Section

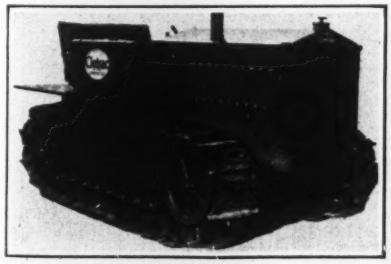
The Bethlehem Steel Company, Bethlehem, Pa., has added a deep arch type section to its line of Lackawanna steel sheet piling designated as Section No. DP165. The chief characteristics of the new section are: Nominal width, 16 in.; thickness of web, ⅜ in.; weight per foot of pile, 33.3 lb.; weight per square foot of wall, 25 lb.; section modulus per foot



of wall, single, 10.07, interlocked, 16.14. The new section is adapted for general use in types of construction where strength and light weight are of importance and where the piling is to be used permanently such as in the case of bulkheads, docks, retaining walls, wharves and similar structures. The interlock is of the double-lock type, which is a well-known feature of Lackawanna piling.

New Tractor Model

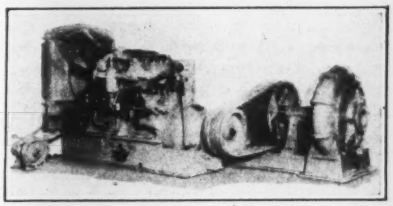
To complete its line of tractors, the Cleveland Tractor Company has developed the "Cletrac 40." This new machine is powered by a six-cylinder, 4½x5-in. motor, developing 40 hp. at the



drawbar and 55 hp. at the belt pulley, and turns in an 11-ft. radius. A tractor of this size is particularly adaptable to highway construction and maintenance.

Sand-Pump Power Unit of Special Design

A sand-pump power unit arranged for installation where direct drive between engine and pump is not advisable is being offered by the Climax Engineering Company, Clinton, Iowa. The drive on this special installation is taken from the engine to the pump through a twin-disk inclosed clutch and a Texrope drive,



the latter furnishing the necessary speed reductions. The engine operates at 950 r.p.m. and the pump at 625 r.p.m. As will be noted in the accompanying illustration, provision is also made for driving a service or priming pump from the front end of the model 4RU 6x7-in. 85-hp. Climax engine. Important features of the unit are ease of portability and light weight.

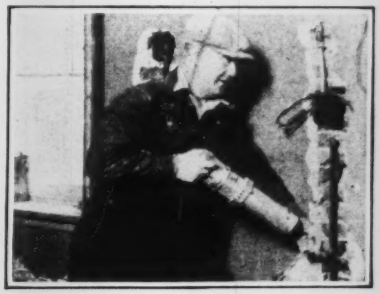
An Improved Instrument for Water Waste Surveys

The manograph, manufactured by Paul Lanham, Lanham, Md., was devised about ten years ago as a portable testing instrument for use in water waste surveys in Washington, D. C. Up to about a year ago the Water Works Equipment Company, New York City, had exclusive sales rights for it. Following the expiration of the sales rights, a new model of the instrument has been devised, improving upon the early instrument, especially by adding an integrator which eliminates the necessity of computation of charts to determine total flow. The manograph is essentially a recording mercury column manometer. The operating principle may be described briefly as follows: The differential pressures, caused by the flow past the Pitot tube or through the Venturi throat, are balanced by a mercury column in a transparent manometer tube. A recording pen geared to a contact rod places the variation in mercury level on a chart. The power for moving the contact rod and pen arm is derived from a differential piston receiving its operating pressure from the water main. An important feature is that the gearing between the contact rod and the pen arm makes it possible to record in a readable manner minute mercury deflections. Changes of mercury levels of less than one thousandth of an inch are claimed to be accurately recorded. The system is designed so that no load is placed upon the mercury column and the friction of the pen arm or other mechanism does not enter into the calibration.

The integrating mechanism consists of a common water meter type straight-reading register driven by a cam and lever from the pen arm. During the manufacture of the manograph the scale and integrator values are determined and the gearing is adjusted to meet the flow conditions. Thus no calibrated or variable factors exist to be adjusted or to be affected by wear or abuse, according to the manufacturer. Ordinary dry cells furnish the electrical energy required and last about one year.

Lightweight Electric Hammer for Contractors' Use

A new small electric hammer operating on an ordinary lighting voltage has been introduced by Black & Decker, Towson, Md., builders, electricians and plumbers. The hammer striking 2,300 blows per minute, will cut a 1-in. hole in concrete at the rate of 3 in. per minute, or in brick at the rate of 8 in. per minute. The new



electric hammer weighs but 15½ lb. and comes in a compact kit with compartments for chucks, turning wrenches and drills.

Manufacturers and Trade Associations

Calendar

Annual Meetings

AMERICAN WATERWORKS MANUFACTURERS ASSOCIATION, New York City; annual meeting, San Francisco, Calif., June 11-14.

New Publications

Electric Motors—RELIANCE ELECTRIC & ENGINEERING COMPANY, Cleveland, Ohio, devotes its bulletin No. 202 to its Type T heavy-duty, direct-current motors with ball and roller bearings.

Welding—FUSION WELDING CORPORATION, Chicago, has published a descriptive bulletin on its arc welders. The bulletin illustrates and describes the welders, which utilize single control and do not require an exciter or rheostat. The machine not only can be used for hand and arc welding but also for carbon arc welding and cutting.

Business Side of Construction

Facts and Events That Affect Cost and Volume

Construction Volume 25 Per Cent Above Last Year to Date

THE construction industry has continued its high activity, with April contract awards valued at $302,728,000, compared with $246,823,000 reported in April, 1927. The year to date shows an increase of 24.5 per cent over last year, with a total of $1,093,523,000 in the four months of 1928 and $877,271,000 in 1927. On the basis of average weekly contract volume, April, 1928, was second only to the record of March, 1928, and December, 1927, was the third highest on record.

Compared with March, 1928, the average weekly volume of awards during April was larger for water-works, sewers, bridges, excavation, streets and roads, public buildings and unclassified projects. Average weekly volume of all public awards increased 56 per cent and all private contracts showed a 21 per cent decrease. Commercial buildings, including public buildings, represented 51 per cent ($155,571,000) of total awards in April, 1928, and in the preceding month this class constituted 61 per cent ($232,231,000) of the total. This large class of construction showed a decrease of 16 per cent from the weekly average of the preceding month, and was 16 per cent above the same month last year.

Street and road awards have shown a steady increase since the first month of this year. The greatest increase from a month ago, 91 per cent, was shown in industrial buildings, which class, however, represented only 5.6 per cent of total construction volume in April, 1928.

April, 1928, compared with a year ago showed larger volume of awards for water-works, sewers, bridges, commercial buildings, unclassified, and streets and roads. Other classes decreased.

There were two sections of the country that showed an increase in average weekly awards in April in comparison with March, 1928. These were the South and Middle West. The only section in which construction volume did not exceed April, 1927, was the South. Cumulated totals of awards since the first of the year are higher than a year ago in the Middle Atlantic (+64 per cent), South (+17), Middle West (+16) and West of the Mississippi (+12) sections; and the decreases in New England and the Far West were 2 and 7 per cent respectively.

The outstanding increase in bridge contracts in comparison with a month ago and last year was due to awards for

(Continued on page 717)

Business Notes

Trade activity lacks uniformity, but seasonal recovery in several major industries has greatly offset irregular trends in lesser lines. The National Bank of Commerce summarizes conditions as follows: "Business is now in the full swing of spring activity. Developments during the last 30 days have been favorable and the outlook is for maintenance of production and consumption at high levels well into May."

Bank debits give a favorable indication of high activity of general trade. The chart at the bottom of page 717 shows 1928 to be on a higher level than last year. This is true of both New York City debits and 261 cities outside New York, and the first three weeks of April likewise exceed the comparable figures of a year ago.

Car loadings have continued the usual seasonal trends, but show a smaller volume of freight than 1927 to date.

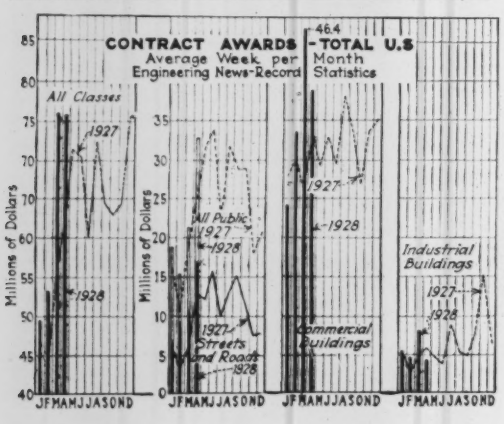
Automobile production volume in March, 1928, exceeds March, 1927, by about 4 per cent. The total number of passenger cars and trucks produced in March was 412,825, or 89,311 more than the preceding month. Reports of registrations are not completely covered by the accompanying chart, p. 717, since several states are not included in the January and February totals.

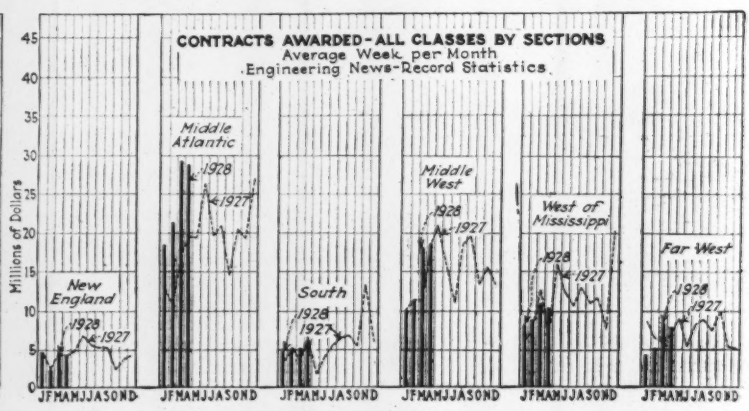
Steel ingot production points to continued favorable conditions in that industry, and a small decline in unfilled orders will probably result in a comparatively small curtailment in operations. The U. S. Steel Corporation is operating in excess of 90 per cent ca-

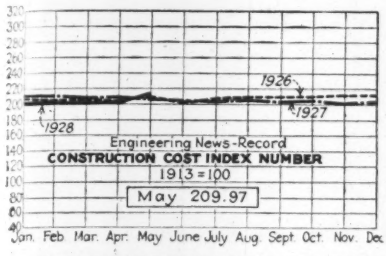
VALUE OF CONTRACTS BY SECTIONS IN THE UNITED STATES AND TOTAL FOR CANADA—APRIL, 1928

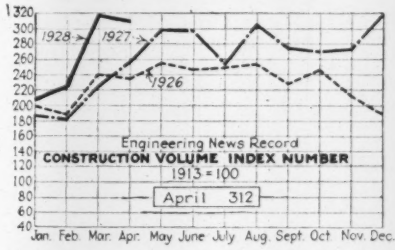
Thousands of dollars (-000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States	Jan. 1 to Date, U. S.	Canada
Water-works	$96	$665	$423	$1,310	$756	$299	$3,549	**$10,914**	$114
Sewers	141	995	466	8,603	726	4,455	15,386	**28,506**	120
Bridges	372	4,336	8,024	790	1,304	472	15,298	**37,921**	3,125
Excavations, drainage, etc.	.....	385	11	13	419	167	995	**5,220**	.....
Streets and roads	2,420	20,530	10,436	19,025	9,286	5,170	66,867	**181,860**	919
Industrial buildings	2,640	2,783	1,362	7,204	2,099	922	17,010	**96,924**	1,395
Commercial buildings	10,958	72,411	2,380	36,466	14,905	26,851	155,571	**617,867**	4,110
Federal government	.....	163	1,311	.....	1,260	343	3,077	**15,325**	.....
Unclassified	391	12,112	367	354	11,058	693	24,975	**98,986**	1,226
April, 1928	17,018	114,380	24,780	73,765	41,813	30,972	302,728	.....	.....
March, 1928	22,190	145,607	26,465	90,028	54,053	41,178	379,521	.....	.....
April, 1927	16,824	77,512	25,895	72,483	26,813	27,296	246,823	.....	.....
Year to date, 1928	**65,568**	**417,611**	**89,284**	**249,354**	**162,253**	**109,453**	.....	**1,093,523**	**750,722**
Year to date, 1927	67,270	255,588	76,388	215,363	144,681	117,981	877,271	.....	23,973









ENGINEERING NEWS-RECORD CONSTRUCTION COST AND VOLUME INDEX NUMBERS

pacity. Activity for the entire industry is about 1 per cent above the last weeks of April, 1927.

Sales of structural steel have been larger in 1928 to date than a year ago and the price of shapes in Pittsburgh has been $1.90 per 100 lb. since the first of March, with recent cutting under to the extent of $1.85.

Cement and lumber shipments increased during March, 1928. Softwood lumber shipped in March exceeded any preceding month of the last two years. Brick shipments have decreased each month since October through February.

Employment and payroll totals reported by the Bureau of Labor are lower than last year, but both have increased from the low points of January, 1928. Wholesale prices, measured by the Bureau of Labor index, are higher than for February and March, 1927. The price index for building materials is about 9 per cent lower than the 1926 average.

Commercial failures compiled by R. G. Dun & Company for the first three months of 1928 are 7, 4 and 5 per cent lower than liabilities in January, February and March, 1927. For actual number of failures, 1928 reports are less favorable than last year, with 6 per cent more failures reported during the first quarter.

Electric power consumption by all industries showed a seasonal movement downward in March, but each month of 1928 has been ahead of a year ago. This year to date shows 4 per cent greater productive activity than 1927 and about 1 per cent above the first quarter of 1926.

Money rates have increased since the first of the year, and several of the Federal Reserve banks have a discount rate of 4½ per cent at present. The security markets, however, as represented by average prices are maintaining unprecedented levels.

Construction Volume Gains

(Continued from page 716)

the Cooper River Bridge in South Carolina, which is estimated to cost $5,750,000. There were three other bridge contracts valued at about a million dollars, Tacony-Palmyra Bridge over the Delaware River, Raritan River in New Jersey, Cape Fear River in North Carolina. An increase of over 500 per cent from April, 1927, in unclassified projects is not so significant because the total for that class of construction for April last year was the smallest for any month in 1926 and 1927.

Although not included in United States contract totals, the award to an American contractor for a part of a large railroad project of the Persian government was an interesting report in April. The total estimate for this project was $80,000,000 and part of the contract was awarded to contractors in Berlin and Frankfort.

CONTRACTS FOR APRIL, 1928, COMPARED WITH AVERAGE WEEK IN APRIL, 1927, AND MARCH, 1928

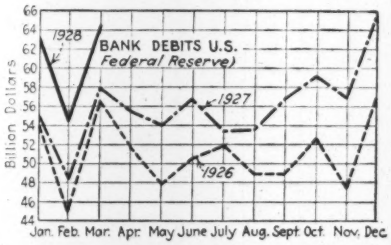
	Per Cent Change From Year Ago	Per Cent Change From Month Ago
Waterworks	+64	+2
Sewers	+136	+22
Bridges	+155	+111
Excavation, drainage, irrigation	+101	—86
Streets and roads	+61	+32
Industrial Buildings	—49	—27
Commercial buildings	—16	+16
Federal government	—39	—19
Unclassified	+6	+540
Total	—0.3	+22

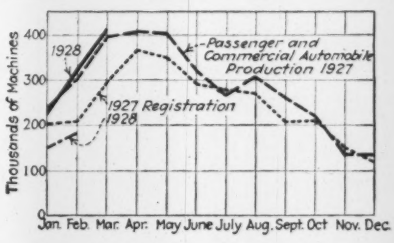
Volume Index Third Highest; Rise of 1.7 Per Cent in Cost

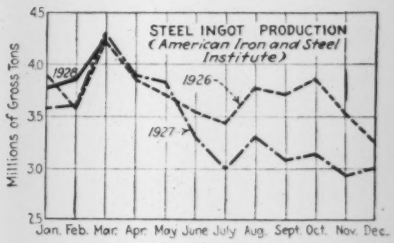
Higher lumber prices have increased the *Engineering News-Record* Construction Cost Index Number to a point 1.7 per cent above the April 1 value. In certain sections of the West, yard stocks are 40 to 50 per cent below normal for the season.

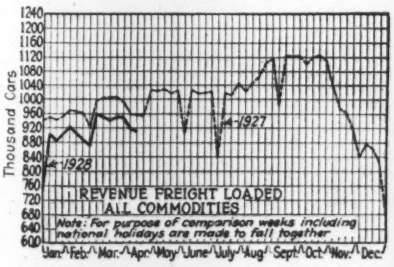
A heavy volume of April contract letting has brought the *E.N.-R.* Construction Volume Index Number to the third highest of any month on record. The highest three months were December, 1927 (319), March, 1928 (318), and April, 1928 (312). The figures, with comparisons, follow:

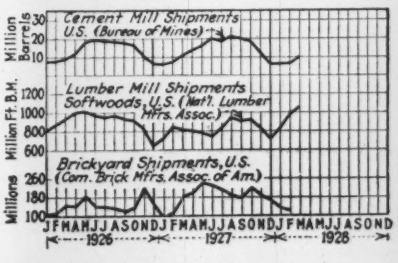
E.N.-R. Cost Index		*E.N.-R.* Volume Index	
May, 1928	**209.97**	**April, 1928**	**312**
April, 1928	206.40	March, 1928	318
May, 1927	206.80	April, 1927	257
Peak, June, 1920	273.80	1927 (average)	263
1927 (average)	206.24	1926 (average)	228
1913 (average)	100.00		
1927		1927	
January	211.50	January	187
February	210.15	February	182
March	208.80	March	226
April	209.00	April	257
May	206.80	May	299
June	205.55	June	297
July	203.68	July	252
August	205.50	August	306
September	203.60	September	273
October	204.40	October	269
November	201.98	November	272
December	203.90	December	319
1928		1928	
January	203.90	January	208
February	204.65	February	225
March	204.65	March	318

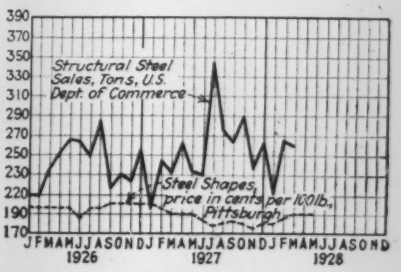



Passenger and Commercial Automobile Production 1927
1927 Registration
1928
Thousands of Machines
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.




REVENUE FREIGHT LOADED
ALL COMMODITIES
Note: For purpose of comparison weeks including national holidays are made to fall together
1928
1927
Thousand Cars
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.


Cement Mill Shipments U.S. (Bureau of Mines)
Million Barrels
Lumber Mill Shipments Softwoods, U.S. (Nat'l. Lumber Mfrs. Assoc.)
Million Ft. B.M.
Brickyard Shipments, U.S. (Com. Brick Mfrs. Assoc. of Am.)
Millions
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928


Structural Steel Sales, Tons, U.S. Dept. of Commerce
Steel Shapes, price in cents per 100 lb., Pittsburgh
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928

STEEL AND AUTOMOTIVE PRODUCTION—CHECKS CASHED AT BANKS—FREIGHT LOADINGS

Five-Day Week in Four Cities—Opposed by Contractors

In the absence of adequate machinery for collecting complete data for all trades, the real extent of unemployment in the United States is difficult to measure. For example, Secretary Davis places the number of idle workers at 1,874,050, whereas Senator Wagner of New York estimates it at 5,796,920. Babson's data indicate that employment of labor throughout the country is about 7½ per cent under that of a year ago.

The most active industries are the construction, automotive and steel. Government figures, released April 27, show notable increases in employment during March in the following industries: shipbuilding, foundry and machine shops, machine tools, sawmills, cast-iron pipe, iron and steel, agricultural implements, stamped ware, automobiles, brick, glass, fertilizers, ice cream and sugar refining. Decreases are reported in four industries: woolen textiles, book and job printing, tobacco and rubber boots.

A survey of the five-day week question, conducted in April by the National Association of Building Trades Employers, shows that in only four cities are all building trades working a five-day week. However, in 66 out of the 75 cities included in the survey, the five-day plan has been adopted by one or more of the building crafts. Contractors' organizations are unanimously opposed to the five-day system. The chief reason given is that it will mean increased costs with consequent discouragement of prospective building. Contractors see in the shorter week the necessity of overtime in order to complete, on a given date, jobs already started. The loss of time occasioned by the shorter working week, together with bad weather, will render the mechanics unable to average their usual weekly or annual incomes. They will then, according to the survey, press for overtime on Saturday evenings and Sundays, thereby increasing contractors' costs.

Cities where the five-day week is being worked by practically all trades are Miami, Atlantic City, Portland (Ore.) and Seattle. The following trades have the five-day week in the cities or localities named:

Painters — Denver, Boston, Long Island, Hammond (Ind.), Baltimore, New York, Atlantic City, Bridgeport, Miami, Portland (Ore.), St. Louis. Five-day week begins June 1 in Schenectady, Scranton, Utica and Seattle.

Plasterers and Lathers—Denver, Pittsburgh, Buffalo, Detroit, Long Island, Baltimore, New York City, Atlantic City, Boston, Dayton, Hammond, Miami, Portland (Ore.), Philadelphia, St. Louis and Seattle.

Carpenters—Denver, Baltimore, Atlantic City and St. Louis.

Bricklayers — Denver, Vancouver, Baltimore, Atlantic City, Miami, Portland and Seattle.

Plumbers—Detroit, Vancouver, Baltimore, Atlantic City, Miami, Portland and Seattle.

Electricians — Miami, Portland, Schenectady, St. Louis and Seattle.

Cement Finishers—St. Louis, Baltimore, Atlantic City and Seattle.

Elevator Constructors—St. Louis.

The average skilled labor rate for the entire country is $1.36⅓ per hour, compared with $1.35 last month and $1.31 in May, 1927. The slight decrease this month was due to wage advances granted bricklayers in Birmingham and Dallas. Common laborers receive an average rate of 55c. per hour, the same as in April, compared with 55½c. in May, 1927.

Following are the wage changes noted in the last month:

	May	April
Bricklayers:		
Dallas	$1.67½	$1.62½
Birmingham	1.50	1.33⅓
Minneapolis	1.25 @1.37½	1.37½
Hoisting Engineers:		
Birmingham	1.25	1.00
Pittsburgh	1.43¾@1.56¼	1.37½@1.50
Structural Ironworkers:		
Montreal	0.80	0.75

Cast-Iron Pipe Rises $1 Per Ton Few Other Price Changes

Building materials as a group show little change from the level of a month ago, but are 4.5 per cent under a year ago. The building materials price level is at approximately that of October, 1927, having recovered from the market dullness of the period extending from November, 1927, to January, 1928.

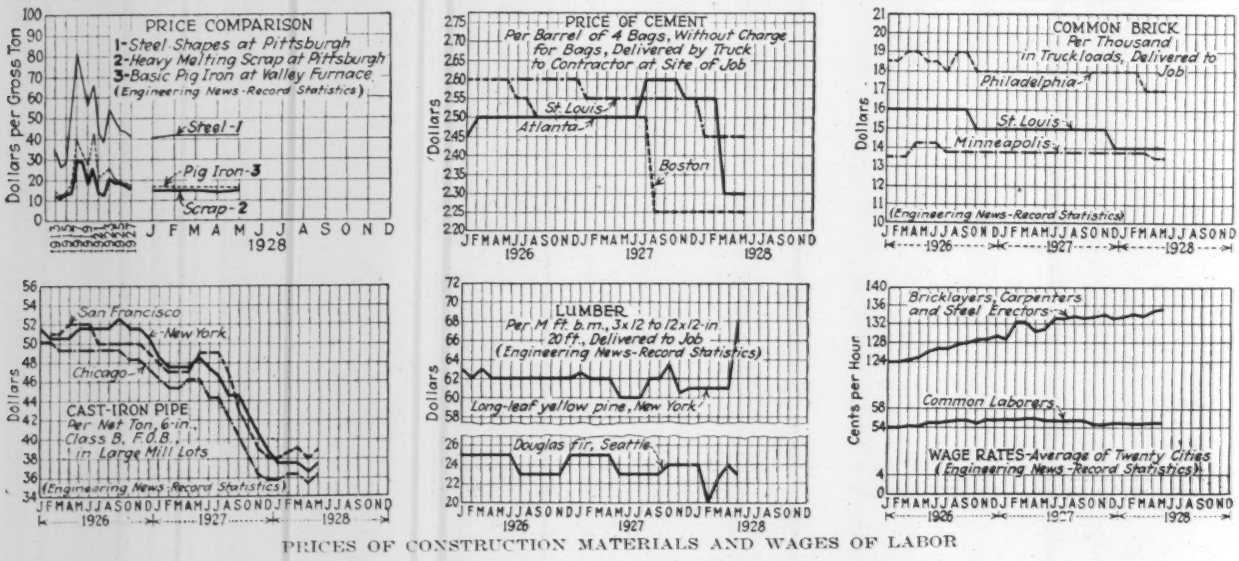
Strength in steel, lumber, cement and brick demand in April, for the country as a whole, served to counterbalance declining price tendencies in the lesser materials. Building materials prices are approximately 5 per cent under those of general wholesale commodities.

The most important price advances of the last month in building materials occurred as follows: brick, $1 per thousand at New York; cast-iron pipe, $2 per ton at Chicago (other cities $1); blue-annealed sheets and standard railway spikes, 10c. and 5c. per 100 lb., respectively, at Pittsburgh; structural rivets, 25c. per 100 lb., Dallas warehouse; hollow tile, Pittsburgh, Cleveland and Detroit.

Price declines occurred as follows: asphalt, 75c. per ton, Baltimore, $1 in Atlanta; wire nails, 10c. per 100 lb., Pittsburgh; granite blocks, 15c. per sq.yd., Baltimore, 30c. per sq.yd. at Detroit; manila rope, 1½c. per lb., Seattle, 2c. at New York and 2½c. in Baltimore; dynamite, 40 per cent gelatin, 0.5c. per lb. at New York and Seattle and 2c. in Atlanta.

Demand for building materials by dealers and contractors during the second quarter as indicated by estimates of freight car requirements for this period, as announced by the American Railway Association, is as follows:

Material	Number of Cars	Per Cent Gain Over Second Quarter, 1927
Clay, gravel, sand, stone and gypsum	1,104,169	8.1
Lumber	1,028,487	1.9
Iron and steel	479,533	2.6
Cement	263,931	6.0
Brick and clay products	209,506	2.6
Lime and plaster	68,154	3.2


PRICE COMPARISON
1-Steel Shapes at Pittsburgh
2-Heavy Melting Scrap at Pittsburgh
3-Basic Pig Iron at Valley Furnace
(Engineering News-Record Statistics)
Steel-1
Pig Iron-3
Scrap-2
Dollars per Gross Ton
J F M A M J J A S O N D
1928
PRICE OF CEMENT
Per Barrel of 4 Bags, Without Charge for Bags, Delivered by Truck to Contractor at Site of Job
St. Louis
Atlanta
Boston
Dollars
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928
COMMON BRICK
Per Thousand in Truckloads, Delivered to Job
Philadelphia
St. Louis
Minneapolis
(Engineering News-Record Statistics)
Dollars
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928
San Francisco
New York
Chicago
CAST-IRON PIPE
Per Net Ton, 6-in. Class B, F.O.B. in Large Mill Lots
(Engineering News-Record Statistics)
Dollars
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928
LUMBER
Per M Ft. b.m., 3x12 to 12x12-in. 20 ft., Delivered to Job
(Engineering News-Record Statistics)
Long-leaf yellow pine, New York
Douglas fir, Seattle
Dollars
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928
Bricklayers, Carpenters and Steel Erectors
Common Laborers
WAGE RATES-Average of Twenty Cities
(Engineering News-Record Statistics)
Cents per Hour
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928

PRICES OF CONSTRUCTION MATERIALS AND WAGES OF LABOR

E. N.-R. Prices of Construction Materials

Price advances since last month are indicated by **heavy type; declines by *italics***

PIG IRON—Per gross ton, f.o.b.:

CINCINNATI	
No. 2 Southern (silicon 2.25@2.75)	$21.44
Northern Basic	20.89
No. 2 Southern Ohio (silicon 1.75@2.25)	21.19
NEW YORK, tidewater delivery	
Southern No. 2 (silicon 2.25@2.75)	25.62
BIRMINGHAM	
No. 2 Foundry (silicon 2.25@2.75)	16.00
PHILADELPHIA	
Eastern Pa., No. 2X (silicon 2.25@2.75)	21.76
Virginia No. 2 (silicon 2.25@2.75)	27.17
Basic	21.26
CHICAGO	
No. 2 Foundry Local (silicon 1.75@2.25)	20.00
No. 2 Foundry Southern (silicon 2.25@2.75)	22.80
PITTSBURGH, including freight charge ($1.76) from the Valley	
No. 2 Foundry Valley (silicon 1.75@2.25)	20.26
Basic	19.26
Bessemer	21.26

SCRAP—The prices following are f.o.b. per ton paid by dealers:

	New York Per Gross Ton	Chicago Per Net Ton	Birmingham Per Gross Ton
No. 1 railroad wrought	$10.00@$10.50	**$11.50@$12.00**	$11.00@$11.50
Stove plate	8.50@ 9.00	12.00@ 12.50	9.00@ 9.50
No. 1 machinery cast	12.50@ 14.00	**14.25@ 14.75**	12.50@ 14.00
Machine shop turnings	*6.50@ 7.25*	7.00@ 7.50	7.00@ 7.25
Cast borings	*6.25@ 7.25*	*8.25@ 8.75*	7.25@ 7.50
Railroad malleable	10.00	*11.75@ 12.00*	10.25@ 10.75
Re-rolling rails	*10.00@ 10.50*	*12.25@ 12.50*	10.25@ 10.75
Re-laying rails	23.00@ 24.00	.....	23.00@ 24.00
Heavy melting steel	*6.75@ 10.75*	*11.00@ 11.50*	.....
Iron and steel pipe	*7.75@ 8.25*	.....	.....

Railway Supplies

STEEL RAILS—Per gross ton f.o.b. for carloads:

	Pittsburgh	Birmingham	Chicago
Standard bessemer rails	$43.00	$43.00	$43.00
Standard openhearth rails	43.00	43.00	43.00
Light rails, 25 to 45 lb.	36.00	34@36	36@38
Re-rolled rails	*30@32*	34@36	.....

RAILWAY TIES—For fair-sized orders, f. o. b., the following prices per tie hold:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
New York	Long-leaf sap pine, untreated	$1.10	$1.30
	Creosoted—prices on application.		
Birmingham	White oak, heart, untreated	1.25	1.45
	White oak, creosoted	1.70	1.90
St. Louis	White Oak, untreated	1.25@1.35	1.50@1.60
	White oak, creosoted	1.50	2.10
Chicago	White oak, heart, untreated	1.40	1.78
	Oak, empty cell, creosoted	1.80	2.40
	Oak, zinc treated	1.60	2.10
San Francisco	Douglas fir, green, untreated	*.82*	1.14
	Douglas fir, empty cell, creosoted	**1.78**	**2.32**

TRACK SUPPLIES—Per 100 lb. f.o.b. Pittsburgh mill for carloads together with warehouse prices at other places named:

	Pittsburgh	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅝-in. and larger	$2.80	$3.55	$3.65	$3.85	$3.00
Track bolts	3.80	4.55	4.65	5.35	3.90
Standard section angle bars, splice bars or fish plates	2.75	3.40	4.25	4.25	....
Tie plates	2.15	.....	.....	.....	.....

Pipe

WROUGHT STEEL AND IRON PIPE—The following discounts from list are for carloads at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1¼	30	13

LAP WELD

1	55	43½	2	23	7
2½ to 6	59	*47½*	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1¼	30	14
2 to 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

WROUGHT-STEEL PIPE—From warehouses at the places named the following discounts from list hold for welded steel pipe:

	Black New York	Black Chicago	Black St. Louis
1 to 3 in. butt welded	53%	54%	49%
2½ to 6 in. lap welded	48%	51%	46%

	Galvanized New York	Galvanized Chicago	Galvanized St. Louis
1 to 3 in. butt welded	39%	41%	36%
2½ to 6 in. lap welded	35%	38%	32%

WROUGHT STEEL PIPE LIST

Size, Inches	List Price per Foot	Diameter in Inches External	Diameter in Inches Internal	Thickness Inches
1	$0.17	1.315	1.049	.133
1¼	.23	1.66	1.38	.14
1½	.27½	1.9	1.61	.145
2	.37	2.375	2.067	.154
2½	.58½	2.875	2.469	.203
3	.76½	3.5	3.068	.216
3½	.92	4.0	3.548	.226
4	1.09	4.5	4.026	.237
4½	1.27	5.0	4.506	.247
5	1.48	5.563	5.047	.258
6	1.92	6.625	6.065	.28
7	2.38	7.625	7.023	.301
8	2.50	8.625	8.071	.277
8	2.88	8.625	7.981	.322
9	3.45	9.625	8.941	.342
10	3.20	10.750	10.192	.279
10	3.50	10.750	10.136	.307
10	4.12	10.750	10.020	.365
11	4.63	11.750	11.000	.375
12	4.50	12.750	12.090	.330
12	5.07	12.750	12.000	.375

CAST-IRON PIPE—Prices per net ton for Class B and heavier, f. o. b., in large mill lots:

	Birmingham	Burlington, N. J.	New York
4 in.	**$32.00**	**$39.00**	**$41.60**
6 in. and over	**29.00**	**36.00**	**38.60**

	Pittsburgh	Chicago	St. Louis	San Francisco
4 in.	**$40.50**	**$41.20**	**$37.60**	**$43.00**
6 in. and over	**37.50**	**38.20**	**34.60**	**40.00**

Gas pipe and Class "A," $3.00 per ton extra.

CLAY DRAIN TILE—Prices are delivered per 1,000 lin.ft.:

Size, In.	New York	St. Louis	Birmingham	San Francisco	Dallas
3	$45.00	$50.00	$45.00	.....	$73.00
4	56.00	50.00	56.00	*$72.00*	110.00
5	.....	.....	80.00	*92.00*	118.00
6	90.00	85.00	105.00	*120.00*	150.00
8	150.00	195.00	175.00	*200.00*	210.00

SEWER PIPE—Prices are delivered in cents per foot for standard pipe; single strength 6, 8 and 12-in. and double strength, 18, 24, 30 and 36-in.:

	6-In.	8-In.	12-In.	18-In.	24-In.	30-In.	36-In.
Atlanta	**$0.16**	**$0.26**	**$0.44**	.....	**$1.65**	.....	.....
Baltimore	.....	**24**	**46**	.....	**1.53**	.....	**$6.50**
Birmingham	.135	.2215	.4015	$1.4625	2.665	$3.96	5.06
Boston	*.135*	.275	**.5175**	.....	**2.00**	.....	5.50
Cincinnati	.....	**.21**	.405	.....	1.35	.....	4.81½
Chicago	.117	.182	.351	1.00	1.80	3.75	5.00
Dallas	.35	.50	.90	1.70	3.00	.....	.....
Denver	.185	.265	.48	1.35	1.65	.....	.....
Detroit	.....	.28	.6075	.....	2.70	.....	.....
Kansas City (f.o.b.)	.....	.....	.52	.....	1.90	.....	3.80
Los Angeles	.21	.27	.486	.....	1.74	.....	.....
Montreal	.....	.45	.75	.....	2.60	.....	.....
Minneapolis	.1575	.25	.45	.....	1.80	3.75	4.94
New Orleans	.195	.325	.5525	1.105	2.112	.....	.....
New York	.22	.35	.61	1.50	2.70	5.12	7.91
Philadelphia	.....	.235	.38	.....	1.33	.....	3.32
Pittsburgh	.1035	.161	.3105	**.90**	**1.62**	**3.024**	**4.8175**
St. Louis	.1645	.26	.468	1.092	1.872	3.65	4.80
San Francisco	.21	.30	*.54*	1.32	2.16	3.60	.....
Seattle	.14	*.22*	*.54*	1.26	*2.16*	3.60	.....

Road and Paving Materials

ROAD OILS—Price per gal. in tank cars, 8,000 gal. minimum, f.o.b., at places named:

New York, 40@50% asphalt	(at terminal)	$0.0725@	$0.075
New York, 50@60% asphalt	(at terminal)	.0675@	.072
St. Louis, 40@50% asphalt		.045	
St. Louis, 50@60% asphalt		.046	
Birmingham, 40@50% asphalt		.0525	
Birmingham, 50@60% asphalt		.0475	
Dallas, 40@50% asphalt		.06	
Dallas, 50@60% asphalt		*.061*	

E. N.-R. Prices of Construction Materials

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (Texas)	$24.50	.....
Boston (Mexican)	24.00	$19.00
Chicago (Texas)	24.50	21.30
San Francisco, (f.o.b. refinery, Oleums Calif.)	18.00	12.00
Dallas (Texas)	26.00	.....
Seattle, ("D" grade, California, f.o.b. Richmond refinery)	19.50	13.50
Denver (California)	24.00	.....
Minneapolis, (Stanolind, f.o.b. Twin Cities)	28.10	22.10
St. Louis (Mexican)	23.50–24.50	19.50–20.50
Baltimore (Standard Oil, f.o.b. refinery)	*21.75*	*17.75*
Montreal (Imperial)	28.00	21.50
Atlanta (Mexican)	*23.60*	*19.40*
Detroit (Mexican)	24.00	19.00
Cincinnati (Kentucky Rock)	.....	11.65
Maurer, N. J. (Bermudez)	30.00	.....
Maurer, N. J. (Trinidad)	23.00	.....
Philadelphia (Mexican)	20.00	18.00
Kansas City, Mo. (Texas)	27.30	22.30
Los Angeles ("D" Grade, California, f.o.b. El Segundo)	18.00	12.00
Birmingham (Mexican)	27.00	21.00
New Orleans (Mexican)	20.00	17.00

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton. Drums used in New York.

PAVING STONE—Prices, f.o.b., in carloads or cargo lots:

New York (grade I)	granite, 5-in., 30 blocks per sq.yd.	$150.00 per M.
San Francisco	Basalt block 4x7x8	70.00 per M.
Chicago	about 5x8x5 dressed	3.60 per sq.yd.
	about 5x8x5 common	3.25 per sq.yd.
Boston	Granite, 5-in.	135.00 per M.
Atlanta	Granite	2.50 per sq.yd.
Detroit	Granite, 5-in.	3.00 per sq.yd.
Baltimore	Granite	3.00 per sq.yd.
Montreal	Granite	104.75 per M.
New Orleans	Granite, 4x8x4	2.75 per sq.yd.
Cincinnati	Granite	110.00 per M.
St. Louis	Granite,	3.35@3.60 per sq.yd.
Kansas City	Granite	2.40 per sq.yd.
Philadelphia	Granite	3.90@4.25 per sq.yd.
Minneapolis	Sandstone	2.74 per sq.yd.

FLAGGING—Prices in fair-sized quantities, alongside dock:

New York	Bronx, 4 ft. wide	$0.24 per sq.ft.
	Manhattan, 4 ft. wide	.24 per sq.ft.
	Queens, 5 ft. wide	.26 per sq.ft.
	6x24-in. cross-walk	1.30 per lin.ft.

CURBING—*New York*: Bluestone, f.o.b. barge, New York, 5x16 in., rough, 90c. per lin.ft., cutting charges extra.

St. Louis: Class "B" straight, delivered, 5x16 in., 85c. per lin.ft.; roundings, $1.16@$1.41 per lin.ft.

Birmingham: Limestone, 5x18-in., f.o.b., $1.05 per lin.ft.

WOOD BLOCK PAVING—Prices f.o.b. in carloads:

	Size of Block	Treatment	Per Sq.Yd.
New York	3	16	$2.40
New York	3½	16	2.70
Boston	3½	18	2.45
Chicago	4	16	2.25
Chicago	3½	16	2.10
St. Louis	3½	16	*2.25*
St. Louis	4	16	*2.50*
Minneapolis	3½	16	2.50
Atlanta	3½	16	2.00
New Orleans	3	16	2.20
New Orleans	3½	16	2.30
New Orleans	4	16	2.40
Dallas	4	18	3.90
Montreal	4	16	4.50
Detroit	3	16	1.94
Cincinnati	3½	16	2.35
Kansas City	4	16	2.50

Construction Materials

SAND AND GRAVEL—Prices are per cu.yd. delivered. Weight of sand, 1½ tons per cu.yd.; gravel, 1½ tons per cu.yd. unless otherwise specified in pounds.

	Gravel 1½ In.	Gravel ¾ In.	Sand
New York	$3.25@$3.50	$3.25@$3.50	$2.00@$2.25
Denver (2,700)	1.50	1.50	.75 at pit
Chicago	*2.15*	*2.15*	*2.15*
St. Louis, per ton	1.45	1.45	1.20@1.45
Seattle (3,200) (2,850)	1.00	1.00	1.00
Dallas	2.50	2.50	2.25
Minneapolis (2,800)	2.25 ton	2.25 ton	1.00
Cincinnati, per ton	1.90	1.60	1.60
San Francisco (bunkers) (2,800)	1.80	1.80	1.40
Boston, per ton	1.90	1.90	1.35
New Orleans (2,700) (2,500)	2.75	2.75	1.75
Los Angeles, per ton	1.80	1.80	1.30
Atlanta, per ton	3.00	3.00	2.25
Detroit (2,600)	3.00	3.00	2.50
Baltimore	2.40	2.60	1.70
Montreal, per ton	1.90	1.50	1.20
Birmingham (2,600)			2.65
Philadelphia, per ton	2.05@2.90	2.05@2.90	1.40@2.25
Kansas City, Mo. at plant	2.40	2.40	.66 at pit
Pittsburgh, per ton	*1.55*	*1.55*	*1.65*

Note: New York gravel weighs 2,800@3,000 lb. and sand, 2,700 lb.

CRUSHED STONE—Prices are per cu.yd. delivered. Weight 1½ tons per cu.yd., unless otherwise specified in pounds:

	1½ In.	¾ In.
New York, Limestone,	$3.25@3.50	$3.25@3.50
Chicago, Limestone	*2.15*	*2.15*
St. Louis, per ton, f.o.b.	1.73	1.73
Dallas	3.25	3.40
San Francisco, Trap rock, bunkers (2,400)	1.70	1.70
Boston, per ton	2.25	2.25
Minneapolis, Limestone, per ton	2.25	2.25
Kansas City, Limestone, at plant, (2,450)	2.40	2.40
Denver, Granite (2,700)	2.50	2.50
Seattle, (2,700)	1.90	1.90
Atlanta, per ton	3.00	3.00
Cincinnati, per ton	2.25	2.25
Los Angeles, per ton	1.80	1.80
Detroit, Limestone, per ton	2.50	2.70
Baltimore	2.75	2.85
Montreal, per ton	.....	2.10
Philadelphia, Limestone, per ton	2.30@3.15	2.30@3.15
Pittsburgh,	*2.50*	*2.50*
Cleveland, per ton	3.00	3.00
Birmingham, Limestone,	2.50	2.50

CRUSHED SLAG—Price of crushed slag in carloads, per net ton, at plant:

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.40	$2.00	$1.30
Buffalo District	1.25	1.35	2.25	1.25
Birmingham, Ala.	.....	1.25	2.05	.....
Cleveland, Ohio	1.20	1.20	.....	1.30
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	....	1.25

LIME—Prices delivered to job:

	Hydrated, per Ton—Finishing	Hydrated, per Ton—Common	Lump, per Barrel—Finishing	Lump, per Barrel—Common
New York	$21.00@22.00	$14.00@15.00	$4.00@4.10*	$3.15@3.25*
Chicago	20.00	18.00	.....	1.50†
St. Louis	24.00	18.00	.....	15.00‡
Boston	19.50	13.50	3.85*	2.75*
Dallas	20.00	.....	.....	18.00‡
Cincinnati	16.80	13.20	.....	13.20‡
San Francisco	27.50	24.50	.....	1.70†
Minneapolis	25.50	21.00	.....	1.70†
Denver	20.00	.....	.....	2.75@3.00*
Detroit	19.20	14.80	2.20†	2.20†
Seattle, paper sacks	24.00	.....	.....	2.80*
Los Angeles	26.00	19.00	2.40†	19.00‡
Baltimore	*20.00*	*14.00*	2.55†	.....
Montreal	.....	21.00	.....	12.00‡
Atlanta	*17.50*	15.00	2.30†	*2.10†*
New Orleans	.....	.....	.....	2.00*
Philadelphia	22.00	15.00	.....	.....
Kansas City	.....	.....	.....	.....
Birmingham	22.50	16.00	2.40†	1.85†
Pittsburgh	22.00	18.00	.....	.....

*Per 280-lb. bbl. (net). †Per 180-lb. (net). ‡Per ton.

NATURAL CEMENT—Prices per bbl. delivered to contractors, without charge for bags:

Minneapolis, Rosendale	.....
Kansas City, Ft. Scott	$1.80
Cincinnati, Utica	1.72
St. Louis, Carney	1.92
Birmingham, Magnolia pozzolan cement	2.60

PORTLAND CEMENT—Prices per bbl. delivered to contractors, in carloads, *without charge for bags.* Cash discount not deducted.

	May 2, 1928	One Month Ago	One Year Ago
New York	$2.25@$2.35	$2.25@$2.35	$2.35@$2.50
Jersey City	2.35	2.13 f.o.b.	2.28 f.o.b.
Boston	2.25	2.25	2.25
Chicago (f. o. b.)	2.05	2.05	2.05
Pittsburgh (f. o. b.)	2.04	2.04	2.04
Cleveland (f. o. b.)	2.24	2.24	2.24
Detroit (f. o. b.)	1.90	1.90	2.15
Indianapolis, (f. o. b.)	2.19	2.19	2.19
Milwaukee (f. o. b.)	2.20	2.20	2.20
Duluth (f. o. b.)	2.04	2.04	2.04
Peoria (f. o. b.)	2.22	2.22	2.22
Cedar Rapids (f. o. b.)	2.24	2.24	2.24
Davenport (f. o. b.)	2.24	2.24	2.24
St. Louis	2.45	2.45	2.05 f.o.b.
San Francisco	2.41	2.41	2.51
New Orleans	2.50	2.50	2.40
Minneapolis (f. o. b.)	2.22	2.22	2.22
Denver	2.85	2.85	2.85
Seattle	2.70	2.65	2.65
Dallas	2.40	2.40	2.05 f.o.b.
Atlanta	2.30	2.30	2.35
Cincinnati (f. o. b.)	2.22	2.22	2.32
Los Angeles	2.66	2.60	2.50
Baltimore	2.65	2.54	2.50
Birmingham	2.60	2.60	2.40
Kansas City, Mo.	2.50	2.50	2.50
Montreal (f. o. b.)	1.41	1.41	1.41
Philadelphia	2.31@2.41	2.21 f.o.b.	2.50
St. Paul (f. o. b.)	2.22	2.22	2.22
Toledo (f. o. b.)	2.20	2.20	2.20

Current mill-prices per barrel, in carloads, without bags, f.o.b., to contractors:

Buffington, Ind	$1.80	Richard City, Tenn	$1.85
Universal, Pa	1.80	North Birmingham, Ala	1.45
Steelton, Minn	1.85	Leeds, Ala	1.65
Fordwick, Va	2.05	Hannibal, Mo	1.90
Mitchell, Ind	1.90	Lehigh Valley District	1.75
Iola, Kan	1.85	Wyandotte, Mich	1.65
Mason City, Ia	1.80	Alpena, Mich	1.60
La Salle, Ill	1.90	Kingsport, Tenn	2.05
Hudson, N. Y	1.75	Clinchfield, Ga	1.65

E. N.-R. Prices of Construction Materials

TRIANGLE MESH—Price per 100 sq.ft. in carloads at mills; from warehouses per 100 sq. ft., in lots of 10,000 sq.ft. or over.

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse: New York*	Warehouse: St. Louis	Warehouse: Dallas	Warehouse: San Francisco
032	22	$0.99	$1.01	$1.39	$1.06	$1.13	$1.22
049	28	1.26	1.29	1.76	1.35	1.38	1.55
068	35	1.54	1.58	2.18	1.66	1.67	1.91
093	45	1.98	2.03	2.79	2.13	2.00	2.46
126	57	2.45	2.51	3.45	2.63	2.55	3.03
153	68	2.92	2.99	4.13	3.14	3.15	....
180	78	3.35	3.43	4.73	3.60	3.47	....
245	103	4.43	4.53	6.24	4.75	4.58	....
287	119	5.12	5.24	7.20	5.50	5.26	6.35
336	138	5.93	6.07	8.36	6.37	6.11	....
395	160	6.88	7.04	9.68	7.38	7.12	....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher.

*Delivered to job. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq.ft.

EXPANDED METAL LATH—Per 100 sq.yd., painted, delivered to job in less-than-carload lots:

Weight in Pounds per Sq. Yd.	New York	Birmingham	Chicago	St. Louis	San Francisco	Dallas
2.2	$19.00	$19.50	$18.00	$16.00	$15.50	$21.50
2.5	20.00	21.50	19.00	17.00	16.50	24.00
3.0	22.00	24.50	21.00	18.50	19.00	
3.4	23.50	27.50	22.50	20.00	21.00	30.50

BARS, CONCRETE REINFORCING—Pittsburgh and Birmingham prices are in carloads, per 100 lb., f.o.b. mill. In other cities listed, prices are per 100 lb., for bars delivered from warehouse stocks.

ROLLED FROM BILLETS

Inches	Pittsburgh	Birmingham	New York	Warehouse: Chicago	Warehouse: St. Louis	Warehouse: Dallas	Warehouse: San Francisco
¾ and larger	$1.85@1.90	$2.00	$3.25*	$2.30@2.75	$3.15	$3.75	$2.25
⅝	1.95@2.00	2.10	3.35*	2.40@2.85	3.25	3.95	2.35
½	2.05@2.10	2.20	3.45*	2.50@2.95	3.35	3.95	2.45
⅜	2.25@2.30	2.40	3.65*	2.70@3.15	3.55	4.10	2.65
¼	2.85@2.90	3.00	4.25*	3.30@3.75	4.15	4.75	3.25

For standard classification of extras for size and cutting of steel bars, see bar card of July 15, 1923. *250 to 3,999 lb.; 249 lb. and under plus extra of 50c. net per order.

BRICK—Contractors price, delivered, per M, is as follows:

	Common	Paving F.O.B.: 3x8¼x4-in.	Paving F.O.B.: 3¼x8¼x4-in.
New York	$17@20	$45.00	$51.00
Chicago	12.00	42.00	45.00
St. Louis, salmon	14.00	40.00 del.	42.50del.
Denver, salmon	8@12	.....	.....
Dallas	15.00	35.00	.....
San Francisco	13.00	.....	.....
Los Angeles	11.00		
Boston	17.50*	45.00 del.	52.00del.
Minneapolis	13.50	.....	.....
Kansas City	14.00	45.00	55.00
Seattle	14.00	.....	55.00
Cincinnati	18.00	40.00	45.00
Montreal	20.33	100.00*	.....
Detroit	15.50	35.50	38.50
Baltimore	15.00	40.00	45.00
Atlanta	12.00	40.00	.....
New Orleans	16.00	60.00	75.00
Birmingham	17.00	50.00 del.	60.00del.
Philadelphia	17.00	40.00	46.00
Pittsburgh	17.00	.....	.....
Cleveland	14@16	.....	.....

*Imported.

HOLLOW TILE—Price of hollow building tile per block delivered to contractors in lots of 2,000 pieces or over:

	4x12x12	6x12x12	8x12x12	10x12x12	12x12x12
Boston	$0.0775	.....	$0.1375	.....	$0.2375
Minneapolis	.0842	.....	.1476	.....	.2441
Cincinnati	.074	.....	.136	.....	.205
Kansas City	.076	.....	.138	.....	.214
Denver	.085	.....	.155	.....	.22
Seattle	.10	.....	.18	.....	.26
Los Angeles	.085	.....	.172	.....	.285
New Orleans	.09	.....	.165	.....	.245
Detroit	.092	.....	.208	.....	.293
Montreal	.12	.....	.22	.....	.315
Baltimore	.095	.....	.173	.....	.232
Atlanta	.0808	.....	.1516	.....	.2232
Dallas	.0985	$0.1205	.1785	$0.284	.....
Birmingham	.068	.09	.126	.158	.186
Pittsburgh	.068	.....	.126	.....	.188
Cleveland	.06	.....	.135	.....	.....
New York	.1004	.1506	.1883	.2385	.318
Chicago	.076	.104	.142	.182	.202
Philadelphia	.11	.....	.22	.....	.34
St. Louis	.078	.105	.145	.175	.210
San Francisco	.108	.156	.255	.....	.....
Perth Amboy, N. J. (f.o.b.)	.....	.....	.....	.252	.312

STRUCTURAL MATERIAL—Pittsburgh and Birmingham prices are in carloads, per 100 lb., f.o.b. mill. At other cities listed, quotations apply on less-than-carload lots delivered from warehouse:

	Pittsburgh	Birmingham	Warehouse: New York	Warehouse: Dallas	Warehouse: St. Louis	Warehouse: Chicago	Warehouse: San Francisco
Beams, 3 to 15 in.	$1.85@$1.90	$2.00	$3.30*	$4.00	$3.25	$3.10	$3.25
Channels, 3 to 15 in.	1.85@1.90	2.00	3.30*	4.00	3.25	3.10	3.25
Angles, 3 to 6 in., ¼ in. thick	1.85@			4.00			
	1.90	2.00	3.30*	4.00	3.25	3.10	3.25
Tees, 3 in. and l'rg'r.	1.85@1.90	2.00	3.30*	4.00	3.25	3.10	3.25
Plates, ¼ in. thick and heavier	1.85@			4.00			
	1.90	2.00	3.30*	4.00	3.25	3.10	3.25

*250 to 3,999 lb.; 249 lb. and under plus extra of 50c. net per order.

RIVETS—The following quotations are per 100 lb., full packages, delivered from warehouse:

ROUND-HEAD STRUCTURAL

	Pittsburgh Mill	Warehouse: New York	Warehouse: Chicago	Warehouse: St. Louis	Warehouse: San Francisco	Warehouse: Dallas
¾ in.	$2.90	$5.00	$3.60*	$3.75	$5.75	$5.00

CONE-HEAD BOILER

¾ in.	$2.90	$5.00	$3.60*	$3.90	$5.75	$5.00

*F.O.B.

NAILS—The following quotations are per 100 lb. keg from warehouse:

	Pittsburgh Mill	Birmingham	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.55@$2.65	3.10	$3.10	$3.60	$4.00	$2.83½	$4.95
Cut	2.80	3.30	....	5.00	5.00	....	5.00

SHIP SPIKES—Current prices per 100 lb. delivered from warehouse:

In.	San Francisco: Galv.	San Francisco: Black	Seattle Black
½	$7.30	$5.55	$7.75
⅜	6.85	5.10	5.65
¼	6.70	4.95	5.50

Pittsburgh base in lots of 200 kegs or more, $3.00 per 100 lb.

PREPARED ROOFINGS—Slate-surfaced roofing in rolls weighing 85 to 90 lb. costs $1.93¾ per square to contractors in carloads, f.o.b. New York.

Single shingles, slate finish, cost $5.62½ per square (sufficient to cover 100 sq.ft.) in carloads f.o.b. New York.

Strip shingles (4 in. by 1 in.) f.o.b. New York, in carloads to contractors, are $4.27½ per square for the hexagonal shape, with Underwriters' label.

ROOFING MATERIALS—Prices f.o.b. New York, to contractors in carloads:

Tar felt per 100 lb.	$2.94½
Asphalt coating, per gal.	31½
Asphalt felt, per 100 lb.	3.09

WINDOW GLASS—United inches 25, bracket size 6x8 to 10x15, discount from jobbers' list at New York warehouses:

Single Thickness		Double Thickness	
AA	83%	AA	83%
A	88%	A	88%
B	90%	B	90%

SHEETS—Quotations are per 100 lb. in various cities out of stock at warehouse; also the base quotations at mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$2.10@$2.20	$3.60	$3.50	$3.85	$3.90*
No. 12	2.15@2.25	3.65	3.55	3.90	3.95*
No. 14	2.20@2.30	3.70	3.60	3.95	4.00*
No. 16	2.30@2.40	3.80	3.70	4.10	4.10*
Black					
Nos. 18 to 20	2.60@2.70	4.25	3.75	4.75	4.00
No. 22	2.75@2.85	4.40	3.90	4.90	4.15
No. 24	2.80@2.90	4.45	3.95	4.95	4.20
No. 26	2.90@3.00	4.55	4.05	5.00	4.30
No. 28	3.05@3.15	4.70	4.20	5.20	4.45
Galvanized					
No. 10	2.95@3.05	4.55	4.10		4.25
Nos. 12 to 14	3.05@3.15	4.65	4.20	4.90	4.35
No. 16	3.15@3.25	4.75	4.30	5.00	4.45
No. 18	3.30@3.40	4.90	4.45	5.15	4.60
No. 20	3.45@3.55	5.05	4.60	5.30	4.75
No. 22	3.50@3.60	5.10	4.65	5.35	4.80
No. 24	3.65@3.75	5.25	4.80	5.50	4.95
No. 26	3.90@4.00	5.50	5.05	5.75	5.20
No. 28	4.15@4.25	5.75	5.30	6.00	5.45

Extra for corrugated sheets, 15c. per 100 lb. *250 to 3,999 lb.; 249 lb. and under plus extra of 50c. net per order.

LINSEED OIL—These prices are for raw oil in barrels, delivered in 5-bbl. lots:

	New York	Chicago	Minneapolis
Per 7½-lb. gallon	$0.76½	$0.78	$0.84½

E. N.-R. Prices of Construction Materials

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry	In Oil
Red	*$13.25*	*$14.75*
White	*13.25*	*13.25*

Lumber

Prices Are Per Thousand Feet, Board Measure

San Francisco—Prices of rough Douglas fir No. 1 common, in carloads, delivered to contractor at site of job:

	10-16-18 and 20 Ft.	22 and 24 Ft.
3x3 and 4	$28.00	$29.00
3x6 and 8	28.00	29.00
3x10 and 12	28.00	29.00
3x14	31.00	33.00

Chicago—Prices f.o.b. per M. ft. b.m.:

	20 Ft. and Under No. 1 Long-Leaf Yellow Pine	Up to 32 Ft. No. 1 Douglas Fir
3x4 to 8x8	$37.50	$39.00
3x10 to 10x10	45.00	39.00
3x12 to 12x12	55.00	39.00
3x14 to 14x14	.....	39.00
3x16 to 16x16	.....	40.50

New York—Delivered prices per M. ft. b.m. to contractors:

	20 Ft. and Under Long-Leaf Yellow Pine	22-24 Ft. Long-Leaf Yellow Pine
3x4 to 8x8	$58.00@63.00	$59.00@64.00
3x10 to 10x10	61.00@66.00	62.00@67.00
3x12 to 12x12	68.00@73.00	69.00@74.00
3x14 to 14x14	75.00@80.00	76.00@81.00
3x16 to 16x16	88.00@93.00	89.00@94.00

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 32 ft. and $1 for each additional foot from 32 to 36 ft.

Other Cities—Delivered to job:

	8x8-In. x 20 Ft. and Under, Rough				3x12 to 12x12-In. 20 Ft. and Under, Rough	
	Pine*	Fir†	Hem-lock	Spruce	Pine*	Fir†
Boston	$47.50	$47.00	$47.50	*$50.00*	*$56.00*	*$54.50*
Seattle	.....	23.00	.....	.....	.....	23.00
New Orleans	40.00	56.00	.....	.....	61.00	61.00
Baltimore	**36.00**	**50.25**	**54.00**	**61.50**	**75.00**	**50.50**
Cincinnati	33.00	46.00	44.00	44.00	37.00	50.00
Montreal	50.00	55.00	.....	.....	49.00	*40.00*
Los Angeles	.....	**39.50**	.....	32.00	.....	**39.50**
Denver	.....	31.75	.....	.....	.....	32.75
Minneapolis	50.00	45.25	36.25	.....	**52.00**	46.75
Atlanta	31.00	.....	.....	.....	45.00	.....
Dallas	**57.50**	.....	.....	.....	**57.50**	.....
Kansas City, Mo.	40.75	38.75	.....	.....	53.75	38.75
Birmingham	35.00	.....	.....	.....	55.00	.....
Philadelphia	54@55	37@38	44@45	45@46	62@63	37@38
Detroit	**55.00**	**55.00**	.....	.....	**65.00**	**65.00**
St. Louis	41.00	.....	.....	.....	51.00	.....

	1x10 In. x 16 Ft. and Under, Common			2x10 In. x 16 Ft. T. & Gr.	
	Pine*	Fir†	Hem-lock	Pine*	Fir†
Boston	$43.00	$42.50	$44.00	$48.00	$47.50
Seattle	.....	22.00	.....	.....	23.50
New Orleans	32.00	.....	.....	40.00	.....
Baltimore	**56.00**	**45.00**	**45.00**	**35.00**	*38.00*
Cincinnati	27.00	32.00	30.00	28.00	45.00
Montreal	45.00	48.00	40.00	85.00	70.00
Los Angeles	.....	**33.50**	.....	.....	**47.50**
Denver	.....	32.25	31.25	.....	30.25
Minneapolis	45.00	39.00	34.75	45.00	40.00
Atlanta	40.00	.....	.....	40.00	.....
Dallas	.....	.....	.....	57.50	.....
Kansas City, Mo.	56.25	41.80	.....	38.00	29.25
Birmingham	36.00	.....	.....	36.00	.....
Philadelphia	31@32	37@38	39@40	58@59	37@38
Detroit	*30.00*	.....	.....	**38.00**	.....
St. Louis	41.00	.....	.....	29.50	.....

*Long-leaf yellow pine. †Douglas fir.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

Miscellaneous

STEEL SHEETPILING—The base price f.o.b. Pittsburgh for large mill lots is $2.25@$2.35 per 100 lb.

CONCRETE BLOCKS—Standard 8x8x16-in., delivered to job, each:

Denver	$0.22	St. Louis	$0.20
Detroit	.15	Boston	18@.20
New Orleans	....	Minneapolis	.14
Brooklyn and Queens	.16@.18	Philadelphia	18@.25
Pittsburgh	.18	Cleveland	17@.18

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized, are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope (add to list)	12½%

California, Oregon, Nevada and Washington: Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¼-in., 8-ft.; ⅜-in., 6-ft.; ½-in., 4½-ft.; ⅝-in., 3½-ft.; ¾-in., 2-ft. 10-in.; ⅞-in., 2-ft. 4-in. Following are prices per pound for ¾-in. and larger delivered in 1200-ft. coils:

Boston	$0.255	New Orleans	$.23½
New York	.24	Los Angeles	.25
Chicago	.21	Seattle	.21½
Minneapolis	.23	St. Louis	.21½
San Francisco	.23½	Montreal	.24½
Atlanta	.25	Detroit	.24½
Denver	.24	Baltimore	.22½
Cincinnati	.21	Kansas City	.29½
Dallas	.21	Birmingham	.35
Philadelphia	.25	Cleveland	.30

EXPLOSIVES—Prices per pound for dynamite delivered in small lots:

	Gelatin 40%	Gelatin 60%
New York (Special gelatin in case lots.)	*$0.26*	*$0.3825*
Boston	.25	.275
Kansas City	.2025	.2225
Seattle	*.16*	*.185*
Chicago (Quantities above 500 lb., but less than a ton.)	.195	.22
Minneapolis	.2017	.2223
St. Louis	.22	.24½
Denver (f.o.b.)	.1975	.22
Dallas	.2325	.2525
Los Angeles (f.o.b. San Fernando Arsenal)	.1875	.2225
Atlanta	*.225*	*.24*
Baltimore	.215	.2375
Cincinnati	.22	.245
Montreal	.195	.22
Birmingham (f.o.b.)	.155	.185
New Orleans	.235	.26
San Francisco	.1625	.1925
Philadelphia	.215	.24

CHEMICALS—Water and sewage treatment chemicals, round lots in the New York market:

Sulphate of aluminum, iron free, in bags, per 100 lb.	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb.	5.05@ 5.10
Soda ash, 58%, in bags, per 100 lb.	1.32@ 1.35
Chlorine, liquid, cylinders, per lb.	.05¼@ .08
Hypochlorite of lime (bleaching powder) in drums, per 100 lb.	2.00@2.10*

* F.o.b. works.

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carload lots of 36,000 lb. or 18 tons:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.735
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.29	St. Louis	.43
Cleveland	.19	St. Paul	.60
Denver	1.15*		

* Minimum carload for structural steel, 50,000 lb.; for other iron or steel products, 80,000 lb.